

Maintenance Manual

MM-008918-001

Rev. J, May 2021



CH-721 Control Heads

CU23218-0001,-0002,-0003, and -0004



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MANUAL REVISION HISTORY

REV.	DATE	REASON FOR CHANGE
E	Apr/11	Revised specifications, introduction, circuit analysis, disassembly and reassembly procedures, and replacement parts, parts lists, and schematic sections.
F	Dec/11	Updated to support OTP release R18D. Added command AT@AUXIO to Table 4-4. Minor updates to circuit analysis. Updated Remote Interface Board schematic.
G	Jul/12	Added information on Remote Interface Board revision D. Revised circuit analysis, disassembly and reassembly procedures, replacement parts, and production changes.
H	May/16	Revised parts list and schematic for display board CB103368V1, Rev. C. Revised Table 4-4 pins 12, 13, and 14 description. Added Environmental specs, preventive maintenance instructions, and cleaning procedures.
J	May/21	Updated cleaning procedures in Section 5.3. Added Section 6.

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1 SAFETY CONVENTIONS

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**WARNING**

The **WARNING** symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** symbol until the conditions identified are fully understood or met.

**CAUTION**

The **CAUTION** symbol calls attention to an operating procedure, practice, or the like, which, if not performed correctly or adhered to, could result in a risk of danger, damage to the equipment, or severely degrade the equipment performance.

**NOTE**

The **NOTE** symbol calls attention to supplemental information, which may improve system performance or clarify a process or procedure.



The **ESD** symbol calls attention to procedures, practices, or the like, which could expose equipment to the effects of Electro-Static Discharge. Proper precautions must be taken to prevent ESD when handling circuit modules.

2 MODELS AND SPECIFICATIONS

2.1 CONTROL HEAD MODELS

Top-level catalog and part numbers are listed in the following tables for the CH-721 Scan and System model control heads.

Table 2-1: CH-721 Part Numbers

PART NUMBER	DESCRIPTION
CU23218-0001	CH-721 Scan Control Head, Local-Control; for use on a front-mount mobile radio
CU23218-0002	CH-721 Scan Control Head, Remote-Control; for use with a remote-mount mobile radio
CU23218-0003	CH-721 System Control Head, Local-Control; for use on a front-mount mobile radio
CU23218-0004	CH-721 System Control Head, Remote-Control; for use with a remote-mount mobile radio

2.2 COMPATIBILITY

Table 2-2: CH-721 Control Heads Catalog Numbers

CATALOG NUMBER FOR M5300	CATALOG NUMBER FOR M7200	CATALOG NUMBER FOR XG-75M/M7300	CATALOG NUMBER FOR UNITY® XG-100M	CONTROL HEAD PART NUMBER
MAHK-NCP9G	(n/a)	MAMW-NCP9G	XMCP9G	CU23218-0001
MAHK-NCP9E	MAMV-CP9E	MAMW-N	XMCP9E	CU23218-0002
MAHK-NCP9H	(n/a)	MAMW-N	XMCP9H	CU23218-0003
MAHK-NCP9F	MAMV-CP9F	MAMW-N	XMCP9F	CU23218-0004

2.3 SPECIFICATIONS¹

2.3.1 General

Dimensions: (Height x Width x Depth)	2.4 x 6.9 x 3.9 inches (6 x 17.5 x 10 centimeters) (Does <u>not</u> include bracket and mounting screws.)
Weight: (Includes Mounting Bracket)	1.7 pounds (0.8 kilograms)
Mounting Methods:	(Refer to the applicable Installation Manual for details.)
Temperature: Operating Ambient Temperature Range: Storage Temperature Range:	-22 to +140° Fahrenheit (-30 to +60° Celsius) -40 to +185° Fahrenheit (-40 to +85° Celsius)
Relative Humidity:	90% non-condensing maximum at 122° Fahrenheit (+50° Celsius)
Altitude: Operating: Storage:	15,000 feet (4572 meters) maximum 50,000 feet (15,240 meters) maximum
DC Supply Voltage: Normal Operating Range: Normal Test Voltage: Overall Operating Voltage:	13.6 Vdc ±10% (Normal operating range per TIA-603) 13.6 Vdc 10.8 to 16.6 Vdc
DC Supply Current (less mobile radio): With ½ Watt Speaker Output Power: With 10 Watts Speaker Output Power: With 15 Watts Speaker Output Power: Standby Current (Muted): Quiescent Current (Powered Off):	0.9 A maximum 2.0 A maximum 2.4 A maximum 0.6 A maximum 100 µA maximum
Internal Reference Clocks: Main Clock: Display Controller Clock: CODEC Clock:	24 MHz ±30 ppm (crystal-based reference clock) 14.7456 MHz (PLL-generated from the main clock) 12.288 MHz (PLL-generated from the main clock)
Display Type:	140 x 32-dot matrix graphical vacuum- fluorescent display (VFD); auto-dimming
User Input Controls:	Power on/off/volume control, three (3) menu buttons, an emergency/home button, a scan enable/disable button, three (3) preset buttons, two (2) ramp controls. System model also has a 12-button keypad.

2.3.2 Audio Interfaces

Audio Frequency Response:	300 to 3000 Hz (transmit and receive)
Microphone Input Sensitivity:	82 ±28 mV rms (typical)

¹ These specifications are primarily intended to be used by the service technician. Refer to the respective specifications sheet for the complete specifications.

Microphone Maximum Audio Input Level:	2500 mV peak-to-peak
Microphone Audio Frequency Response:	±0.5 dB from 100 Hz to 3000 Hz
Microphone Input Impedance:	600 ohms
Microphone Connector:	17-pin Conxall-style flush-mount thumbscrew-locking connector located on front panel of control head.
Microphone Types Available:	Standard, DTMF, and Noise-Canceling
Speaker Audio Output Power:	15 watts RMS minimum into 4-ohm external speaker
Speaker Audio Output Distortion:	< 5% at 15 watts RMS into 4-ohm speaker load
Headset Audio Output Power:	
At CH-721 Microphone Connector:	1 watt minimum into 4-ohm headset/speaker
At CH-721 DB-25 Rear Panel Connector:	35 milliwatts maximum into 24-ohm headset
External Speaker Connection:	
Local Control (Front-Mount Radio):	2-pin audio connector on rear of radio
Remote Control (Trunk-Mount Radio):	2-pin audio connector on rear of control head
Mic A-D and Speaker D-A Audio Conversion:	
CODEC Audio Sampling Rate:	8 kHz
CODEC Algorithm (Vocoding Method):	Sigma-Delta

2.3.3 CAN Link Interface

Physical Connection:	
Local-Control (Front-Mount Radio):	2-Wire differential connection (with ground) via flex-strip connections between control head and radio.
Remote-Control (Trunk-Mount Radio):	2-Wire differential connection (with ground) via 3-pin connectors on rear panel and associated CAN link cable(s)
Terminating Impedance:	120 ohms
Maximum Cable Length:	250 feet (76.2 meters)
Protocol:	CAN 2.0B
Maximum Data Rate:	512 kbps (256 kbps available for voice and data)
Maximum Number of CAN devices:	6 (one radio plus five control heads)

2.3.4 Mobile Data Interface

Physical Connection:	
Local-Control (Front-Mount Radio):	Port available from connected mobile radio (not available from control head)
Remote-Control (Trunk-Mount Radio):	TIA/EIA/RS-232 serial interface port with hardware flow control via 9-pin D-subminiature (DB-9) connector on control head's rear panel
Protocol:	Serial Line Internet Protocol (SLIP) / RFC 1055
Data Rate:	19.2 kbps

2.3.5 Regulatory

Applicable FCC Rules:

Part 15

2.3.6 Environmental

The CH-721 Scan and System Control Heads meet the following environmental specifications:

Table 2-3: CH-721 Control Head Environmental Specifications

DESCRIPTION	APPLICABLE STANDARD	METHOD OR SECTION	PROCEDURE
Low Pressure	MIL-STD-810G	500.5	I & II
High Temperature +60°C Operating +80°C Storage	MIL-STD-810G	501.5	I & II
Low Temperature -30°C Operating -57°C Storage	MIL-STD-810G	502.5	I & II
Temperature Shock -30°C to +60°C	MIL-STD-810G	503.5	I-B
Solar Radiation (240 Hours)	MIL-STD-810G	505.5	II
Blowing Rain	MIL-STD-810G	506.5	I
Humidity	MIL-STD-810G	507.5	II
Salt Fog	MIL-STD-810G	509.5	I
Blowing Dust	MIL-STD-810G	510.5	I
Basic Transportation Vibration	MIL-STD-810G	514.6	I, CAT 4
Min Integrity Vibration	MIL-STD-810G	514.6	I, CAT 24
Functional/Basic Shock	MIL-STD-810G	516.6	I
Transit Drop	MIL-STD-810G	516.6	IV
Vibration Stability	U.S.F.S.	Par. 2.15	N/A
IP-65	IEC 60529	Par. 13.4, Par. 14.2.5	N/A

3 INTRODUCTION

This manual provides maintenance information for the CH-721 Scan and System model control heads, for both local and remote-control mobile radio applications. A local-control version of the CH-721 is an integral part of a front-mount radio (also referred to as a dash-mount radio). The remote-control version of a CH-721 is used with a remote/trunk-mount mobile radio installation.

3.1 DESCRIPTION

The CH-721 Scan model control head features large menu selection buttons. The System model control head has a 12-button keypad to allow advanced operations without the need of a DTMF microphone. Button key-caps are removable/changeable to support customized button text.

Figure 3-3 on page 13 illustrates the rear panel of the two remote-control control head models. Both models have identical rear panels and rear panel connectors.

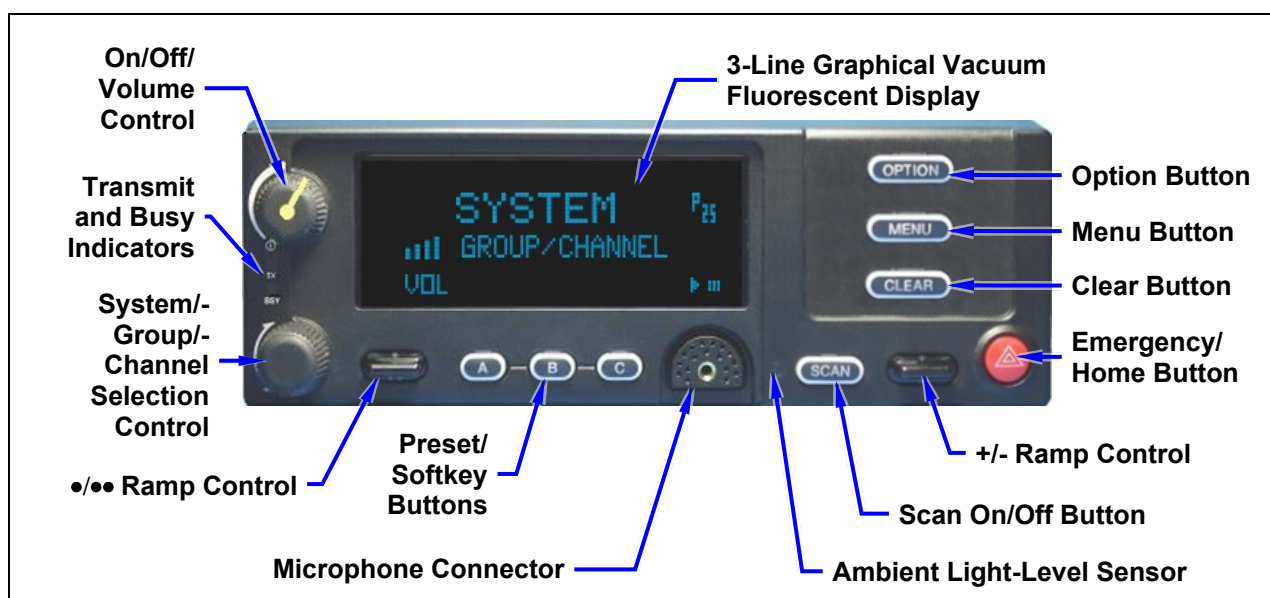


Figure 3-1: Front Panel of CH-721 Scan Model Control Head (Local and Remote-Control)

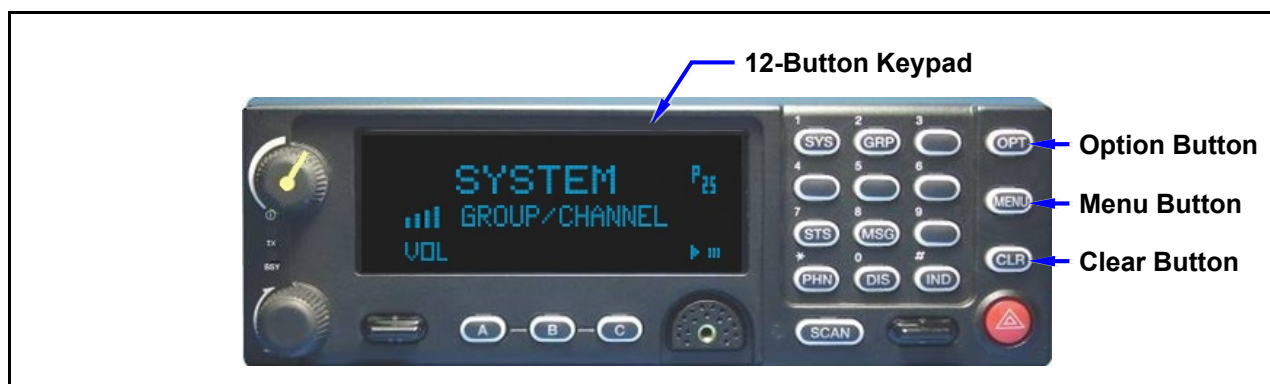


Figure 3-2: Front Panel of CH-721 System Model Control Head (Local and Remote-Control)

The CH-721 control heads meet or exceed many tough environmental specifications included within military standard MIL-STD-810F, automotive industry standard SAE-J1455, the radio industry standard TIA/EIA-603, and the radio standard established by the U.S. Forest Service.

The CH-721 control heads feature a large easy-to-read 3-line graphical vacuum fluorescent display, an on/off/volume control knob, menu controls and buttons, trunking mode buttons, an emergency/home button, a scan on/off/volume control, and three (3) preset buttons. Other front panel components include a microphone connector and LED-type indicators. One LED indicator is the busy indicator that lights when the radio is receiving a call and one is the transmitter-enabled indicator that lights when the radio is transmitting. The front panel also has an ambient light sensor for automatic display dimming.

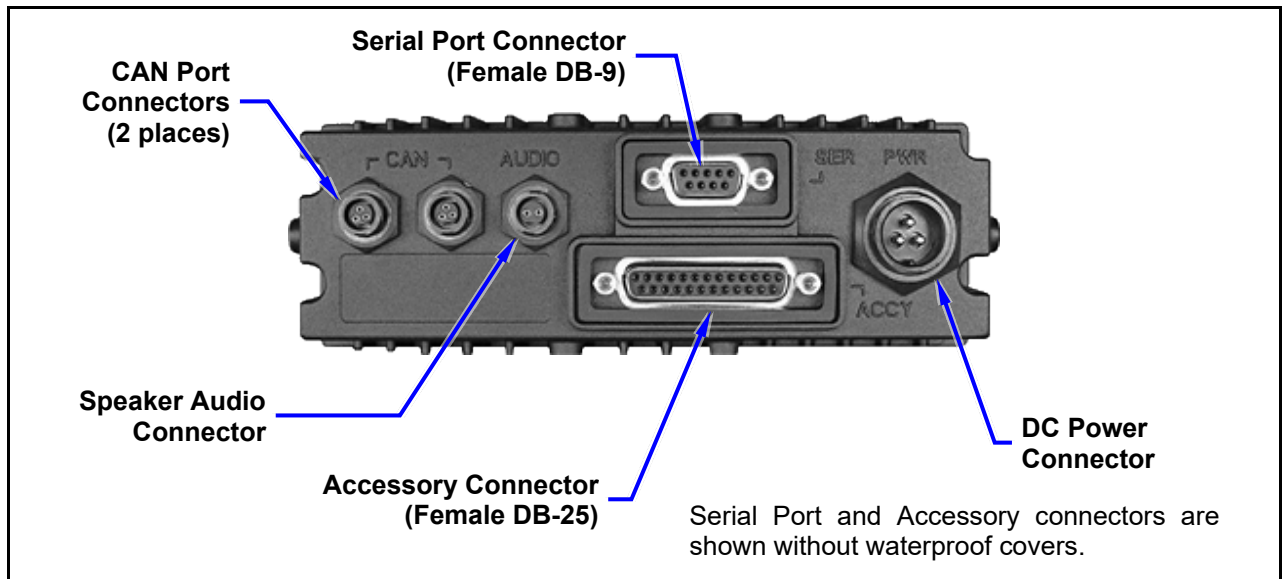


Figure 3-3: Rear Panel of CH-721 Control Head (Remote-Control Only)

In a mobile installation, more than one control head can be connected to one mobile radio for multi-head installations. A multiple control head installation may be required in a vehicle such as a fire truck or any large vehicle where more than one operator may require use of the radio. Multi-head installations also provide other benefits such as intercom operations.

3.2 CH-721 CONTROL HEAD ASSEMBLIES

Each control head model is made from a Front Cover Assembly and a Rear Housing Assembly. There are two unique Front Cover Assemblies—one for the Scan model control head and one for the System model control head. Likewise, there are two unique Rear Housing Assemblies—one for local-control control applications (i.e., front-mount radio installations) and one for remote-control applications (i.e., remote/trunk-mount radio installation). Respective mechanical assembly diagrams are shown on pages 65 through 73.

3.2.1 Front Cover Assemblies for Scan and System Models

The Front Cover Assembly is the radio user/operator input and output control point for the mobile radio. The respective mechanical assembly diagrams are shown on pages 69 (Scan) and 70 (System). As illustrated in Figure 3-1 and Figure 3-2, user input controls include power on/off and volume control, navigation buttons for menu selection, an emergency and three preset buttons, and microphone audio and push-to-talk (PTT) inputs via a microphone attached to the unit's microphone connector. Outputs include the visual information provided by the display and demodulated receiver audio. In remote/trunk-mount mobile radio installations, the CAN link between the radio and control head is the interface link. Demodulated receiver audio is sent to the control head's speaker amplifier circuit located in the Rear Housing Assembly. The CAN link interface between the boards in the Front Cover Assembly and the Rear Housing Assembly provides the data communication path for the mobile-to-control head CAN link.

Board assemblies in each Front Cover Assembly include a Display/DSP Board and a Keypad Board. Other components include user input control components including the on/off/volume control, system/group/channel selection control, keypad buttons. Also, mechanical components include the die-cast aluminium case, EMI shielding, and related hardware.

The Front Cover Assembly mates with the Rear Housing Assembly to form a complete control head. In a local/front-mount radio application, one multi-conductor flex strip interconnects the Display/DSP Board in the Front Cover Assembly to the PK Board in the mobile radio. In a remote/trunk-mount radio application, three (3) multi-conductor flex strips are utilized to interconnect the Display/DSP Board in the Front Cover Assembly to the Remote Interface Board in the Rear Housing Assembly.

3.2.1.1 Display/DSP Board

A common Display/DSP Board is used in all models of the CH-721 control head. This board contains the head's large easy-to-read graphical vacuum fluorescent display, display controller and driver circuits, receiver audio decoding circuits, microphone audio encoding circuits, CAN link messaging circuits, and various other supporting circuits such as voltage regulators and serial port interface circuits. Audio encoding and decoding is performed by the board's Digital Signal Processor (DSP), which is also the main processor on the board, performing all controlling functions for the control head. For detailed circuit analysis information, refer to Section 4.1 which begins on page 16. The board's assembly diagram is shown on page 74.

3.2.1.2 Keypad Boards

Each CH-721 control head has a Keypad Board located at the front-inside of the Front Cover Assembly. There are two (2) separate Keypad Boards: one for the Scan Front Cover Assembly used with the Scan model control head, and one for the System Front Cover Assembly used with the System model control head. The System Keypad Board has additional switch contacts to support the 12-button keypad of the System model CH-721 control head. Both Keypad Boards feature backlit buttons implemented via numerous bi-color (yellow-green) light-emitting diodes (LEDs). For circuit analysis information, refer to Section 4.2 which begins on page 28. Assembly diagrams are shown on pages 81 and 82.

3.2.2 Rear Housing Assemblies

There are two different CH-721 Rear Housing Assemblies. One is utilized in local-control applications as a part of a front-mount radio installation and one is utilized in remote-control applications to support a trunk-mount radio.

The Rear Housing Assembly shown on page 72 is used in local-control applications. This assembly has no electronic components itself. It mechanically connects a Front Cover Assembly to a mobile radio housing/casting.

The Rear Housing Assembly shown on page 73 is used in remote-control applications (i.e., trunk-mount radio installations). It is a common assembly for both the CH-721 Scan and the CH-721 System model control heads. It mates with the Front Cover Assembly to form a complete control head. Primary components include the die-cast rear case, connectors at the rear of the assembly, and the Remote Interface Board inside the assembly. Multi-conductor flex strips provide electrical interconnections between the boards in the Front Cover Assembly and the Rear Housing Assembly.

3.2.2.1 Remote Interface Board

The Remote Interface Board mounts directly to the inner rear surface of the Rear Housing Assembly used in remote-control applications. This board is not employed in local-control versions of the CH-721 control head. Circuits on this board include a 15-watt audio amplifier for driving the external speaker connected to the control head, an electronic on/off switch circuit, an ignition switch interface circuit, passive interconnections between the Display/DSP Board and the connectors on the rear panel, and serial transceivers that support serial port interfaces at the rear panel of the control head. Refer to Section 4.3 on page 30 for circuit analysis information.

4 CIRCUIT ANALYSIS

Electronic circuits of the CH-721 printed circuit board assemblies are analyzed in the following sections.

4.1 DISPLAY/DSP BOARD

4.1.1 Overview

Circuits on the CH-721's Display/DSP Board include:

- **Display Circuits** — The Display/DSP Board's display circuits include the 140 x 32-dot matrix graphical vacuum-fluorescent display (VFD), display control and driver logic, a 43 V step-up switching voltage regulator for display power, and an on/off switch circuit that turns both display filament power and 43 V power on and off. Operating on 5 V regulated power from the power supply circuits, the display circuits are controlled by the board's 32-bit Digital Signal Processor (DSP) via a 2-line asynchronous serial interface link. Manual and automatic display dimming is performed digitally over the serial link based on user input control. The display can operate in either a three- or four-text-line mode with simulated 5 x 7-dot characters, and graphical-based characters.
- **Digital Signal Processor U9** — DSP U9 is the "brain" of the Display/DSP Board. It receives messages from and transmits messages to the mobile radio via the CAN link interface. It also performs speech DSP compression/encoding for microphone audio signals, and DSP speech decompression/decoding for demodulated receive audio signals. Utilized DSP-based algorithms include AMBE® for OpenSky radio networks, and IMBE™ for EDACS/ProVoice™ and Project 25 (P25) radio networks. DSP U9 has 1.8 V core logic and 3.3 V interface logic. U9 is the main processor on the board, performing all controlling functions for the control head per the firmware flashed into it. CH-721 operating firmware is flashed into U9 at the factory. This firmware can be manually flash-updated via the control head's serial port if required. In addition, the connected mobile radio can be programmed to automatically send new CH-721 firmware to the control head via the CAN link.
- **Coder-Decoder (CODEC)** — The primary component in the Display/DSP Board's CODEC circuit is high-performance 16-bit CODEC U7. This integrated circuit performs digital-to-analog (D/A) conversion of receive audio signals, and analog-to-digital (A/D) conversion of microphone audio signals. CODEC U7 employs Sigma-Delta conversion techniques. It also performs other audio-related functions such as digital volume control for the receive audio path, and mic audio gain control in the transmit audio path.
- **Input/Output (I/O) Interface** — The Display/DSP Board's I/O interface circuits include keypad/button scanning logic, a 4-channel Asynchronous Communication Element (ACE) circuit, a CAN link interface circuit, microphone audio and serial data interface circuits, speaker and headset audio interface circuits, and surge protection components. I/O interface circuits also include those supporting connections to the DB-25 accessory connector on the rear panel of the control head. The board's main reference 24 MHz clock clocks the ACE, the DSP U9, and the display controller logic. Serial interfaces provided by the ACE support the control head's microphone serial interface at the mic connector, and the programming and mobile data terminal (MDT) serial interface connections provided by the DB-25 pin connector at the rear panel of the control head.

- **Reference Oscillator and Clock Generators** — The Display/DSP Board has a crystal-based reference oscillator that generates a 24 MHz reference clock for the entire board. This oscillator directly clocks the board's CPLD and an on-board clock generator. The clock generator has internal phase-locked loops that generate 12.288 MHz and 14.7456 MHz clocks from the 24 MHz clock. The 14.7456 MHz clock output clocks the board's display controller and the ACE, and the 12.288 MHz clock output clocks the board's CODEC.
- **Power Supply Regulators** — From the filtered DC power (typically 12 to 14 volts) supplied to the board, three (3) switching voltage regulators on the Display/DSP Board generate 1.8 V, 3.3 V, 5 V regulated supplies for all circuits on the board. For a remote-control head, the regulated 3.3 V and 5 V power is also delivered to the control head's Remote Interface Board and Keypad Board via the multi-conductor flex strips interconnecting the boards. In addition to routing DC power between the board, these flex strips also provide signal interconnections between the boards.

4.1.2 DC Power Input

If the Front Cover Assembly is a part of a local-control head in a front-mount radio, filtered DC power (typically 12 to 14 V) is delivered from the radio's PK Board to the Display/DSP Board in the Front Cover Assembly.

If the Front Cover Assembly is a part of a remote-control head of a remote-mount radio installation, filtered and switched DC power (typically 12 to 14 V) is delivered from the Remote Interface Board located in the Rear Housing Assembly to the Display/DSP Board in the Front Cover Assembly.

The control head's Remote Interface Board supplies on/off-switched unregulated DC operating power to the Display/DSP Board via the SWA+ supply line. The typical voltage range for SWA+ is 12 to 14 volts. However, since SWA+ is very near vehicle battery voltage potential in a mobile installation, it can drop considerably below 12 volts, such as during engine starting.

SWA+ is applied to the Display/DSP Board via Display/DSP Board flex-strip connectors J8, J9 and J10. These connectors are shown on sheets 6 and 7 of the Display/DSP Board schematic. As illustrated in the internal interconnection diagram on page 115, J8 mates with Remote Interface Board connector J6, J9 mates with Remote Interface Board connector J5, and J10 mates with Remote Interface Board connector J8. The rotary on/off switch on the control head's front panel and a DSP-controlled latch circuit on the Display/DSP Board control the respective electronic on/off switch circuit on the Remote Interface Board. Refer to Section 4.3 beginning on page 30 for additional information.

On the Display/DSP Board, SWA+ is disturbed to the board's three (3) switching regulators via several L-C filter networks and the SWA+F filtered DC supply line. Filter components include L10 and L14 and the associated capacitors shown on sheet 8 of the Display/DSP Board schematic, L7 shown on sheet 6 of the Display/DSP Board schematic, and the respective L-C networks on the Remote Interface Board. The three switching regulators source DC power to the board's three main regulated power supply lines.

4.1.3 Regulated DC Power Supplies

The control head's Display/DSP Board has three (3) on-board switching voltage regulator circuits that deliver regulated DC operating power to most Display/DSP Board circuits, and to circuits on the head's Remote Interface Board and Keypad Board. A surface-mounted dual switching voltage regulator, integrated circuit U17 on the Display/DSP Board, is the key component for the 5 V and 3.3 V supplies. The 1.8 V regulator's key component is a surface-mount switching voltage regulator, integrated circuit U18 on the Display/DSP Board.

4.1.3.1 3.3 V and 5 V Switching Regulators

The Display/DSP Board's 3.3 V and 5 V switching voltage regulator circuits are shown on sheet 8 of the schematic. Each regulator is formed by one-half of dual switching voltage regulator U17 and the associated components. The 3.3 V regulator supplies regulated 3.3 VDC power to the DSP and CODEC-related circuits on the Display/DSP Board. The 5 V regulator supplies regulated 5 V DC power to other logic circuits on the Display/DSP Board, and to the on-board headset amplifier circuit (shown on sheet 1 of the schematic). The 5 V regulator also feeds the logic circuits on the Remote Interface Board and Keypad Board via the associated flex strip interconnections. The switching regulator circuits are highly-efficient step-down DC-to-DC buck converters. Conversion efficiency exceeds 80% in most cases. Both regulators are completely powered-down when the control head is powered off. This results in extremely low control head current drain from the vehicle's battery during power-off conditions.

U17 is a Linear Technology LT1940EFE (or equivalent) current-mode pulse-width modulated switching voltage regulator that contains two independent switching regulators. It is housed in a 16-pin TSSOP-type surface-mount package and it is mounted on the secondary side of the board, near 12-contact flex-strip connector J4. U17 ground connection is provided by a relatively large metallic pad on the bottom of the IC that is soldered to a ground pad on the printed circuit board. This solder connection also provides cooling for U17 since heat which it generates can readily transfer into the printed circuit board.

Both the 3.3 V and the 5 V regulators operate at a fixed switching frequency of 1.1 MHz. Two respective oscillators within U17 are synchronized together at opposite phases. This lowers input ripple current on the SWA+F input supply line that feeds U17.

As previously stated, SWA+F is a filtered version of the switched and unregulated SWA+ supply line from the control head's Remote Interface Board. SWA+F is applied to the positive DC inputs of U17 at pins 3 through 6. Bypassing is provided by C102 located near these pins.

Each regulator circuit has separate output and feedback components on the respective side of U17. Side 1 is the 5 V regulator side and side 2 is the 3.3 V regulator side. The 3.3 V output is identified 3.3 V on the schematic, and the 5 V output is identified 5 V.

For the 3.3 V regulator, output components include Schottky diodes D11 and D12, inductor L11, and the associated capacitors. L11 is the driven inductor, D11 is the buck/catch diode, C113 is the output filter capacitor, and C112 is the decoupling and bypass cap. C107 and D12 at U17 pin 8 generate a boost supply for the respective output driver within U17 that drives the internal NPN output transistor at this side of the regulator. At U17 pin 9, feedback components include voltage divider resistors R118, R119 and feed-forward cap C110. When the output is regulated at 3.3 V, the feedback voltage at U17 pin 9 remains 1.25 Vdc. This voltage is established by the respective internal voltage reference within U17, along with the feedback resistors and regulation action of U17. C106 at U17 pin 12 establishes a regulator soft-start time period at control head power-up.

For the 5 V regulator, output components include Schottky diodes D9 and D10, inductor L9, and the associated capacitors. L9 is the driven inductor, D10 is the buck/catch diode, C97 is the output filter capacitor, and C96 is the decoupling and bypass cap. C100 and D9 at U17 pin 1 generate a boost supply for the respective output driver within U17 that drives the internal NPN output transistor at this side of the regulator. At U17 pin 16, feedback components include voltage divider resistors R113, R114 and feed-forward cap C98. When the output is regulated at 5 volts, the feedback voltage at U17 pin 16 remains 1.25 VDC. This voltage is established by the respective internal voltage reference within U17, along with the feedback resistors and regulation action of U17. C105 at U17 pin 13 establishes a regulator soft-start time period at control head power-up.

The 3.3 V and 5 V regulators can each supply up to 1.4 amps of current to their respective loads. However, actual current demands are considerably lower.

4.1.3.2 1.8 V Switching Regulator

The Display/DSP Board's 1.8 V switching voltage regulator circuit is shown on sheet 8 of the Display/DSP Board schematic. This regulator supplies DC operating power to the cores of DSP U9 and CPLD U22. U9 is shown on sheet 5 of the Display/DSP Board schematic and U22 is shown on sheet 9. This regulator is powered by the 3.3 V supply line from U17 and the associated components. U18 is the key component in the 1.8 V switching regulator circuit.

U18 is a Linear Technology LTC3411 (or equivalent) synchronous step-down pulse-width modulated switching voltage regulator. It is a highly-efficient current-mode switching voltage regulator. In this application, the synchronous functionality is not needed and not employed. U18 is housed in a 10-pin MSOP surface-mount package. This regulator can supply up to 600 milliamps to the on-board circuits. Conversion efficiency exceeds 90%. Like the 3.3 V and 5 V regulators, this regulator is completely powered down when the control head is powered off.

U18 runs at a frequency of approximately 1.8 MHz per R123 at U18 pin 1. This frequency allows the use of a small output inductor and output filter capacitors even with the relatively heavy current demand from the supply. Pin 1 is also a shutdown input controlled by the "power good 2" output from U17 pin 11 via transistor Q12. During normal operation, U17 pin 11 remains high so Q12's collector pulls the junction of R123 and R202 to ground potential. At control head power-up, U17 pin 11 remains low for a short period of time (until the 3.3 V supply line becomes stable). During this time, Q12 remains off, placing U18 in shutdown mode.

Inductor L12 at U18 pin 4, together with capacitor C117 form an output filter for the 1.8 V supply line. 1.8 V supply power is distributed to the respective power pins for the DSP and CPLD cores. C116 provides decoupling and bypass functions.

1.8 V DC voltage regulation is maintained using feedback divider resistors R120 and R121 at U18 pin 9, and a 0.8 V voltage reference within U18. When the circuit's output is in regulation (1.8 V supply line = 1.8 volts), these divider resistors produce 0.8 volts at U18's feedback voltage input pin, U18 pin 9. Varying current loads on the 1.8 V supply line cause U18 to change its output duty cycle to maintain voltage regulation. During 3.3 V supply brown-out conditions, U18 can operate at a duty cycle of up to 100% to maintain output regulation for the DPS and CPLD core logic.

The R-C components at U18 pin 10 provide loop compensation for the error amplifiers within U18. In addition, they also establish turn-on soft-start current-limits at control head power-up. This soft-start functionality reduces current surges on the 3.3 V supply line at power-up.

4.1.3.3 Analog Power Supply (Van)

The Display/DSP Board has a 3.3 V analog power supply line that feeds the VOLHI attenuator/buffer op-amp stage in the CODEC section. This source is a filtered version of the 3.3 V switching regulator circuit (U17 and the associated components). The filter network is shown on sheet 4 of the schematic, just above CODEC U7. Refer to Section 4.1.11 on page 27 for additional information.

4.1.4 DC Input Over-Voltage Detector

The DC input over-voltage detector is shown on sheet 8 of the schematic. U21 and the associated components form an over-voltage detector circuit for the control head's DC input power (e.g., vehicle battery power). This circuit's output is periodically monitored by Display/DSP Board DSP firmware using a logic input bit at CPLD U22. CPLD U22 is shown on sheet 9 of the Display/DSP Board schematic.

U21 contains a 0.6 V voltage reference, and a voltage comparator with an open-drain Field-Effect Transistor (FET) output stage. It has a 4-pin SC70 surface-mount package, and it is located on the secondary side of the board, near 12-contact flex-strip connector J4. Inside U21, the voltage reference is applied to the non-inverting input of the comparator. U21 pin 1 is the comparator's inverting input.

The voltage divider formed by R130 and R131 samples the unregulated DC input voltage on the SWA+F input supply line. The sampled voltage is applied to the comparator's inverting input at U21 pin 1. When the control head's DC input power on SWA+F is within or below the normal operating range of 12 to 14 VDC, U21 pin 1 remains below 0.6 volts, so the open-drain output at U21 pin 3 is pulled high (to near 3.3 V) by R129. However, if the control head's DC input power on SWA+F exceeds approximately 18 VDC, U21 pin 1 remains above 0.6 VDC so U21 pin 3 pulls the OVER_18 logic line low (to near 0 V). This line is applied to a logic input at CPLD U22 pin 18. U22 is shown on sheet 9 of the Display/DSP Board schematic. DSP U9 can then monitor OVER_18 by reading this CPLD U22 input.

4.1.5 Reset Supervisor

Integrated circuit U19 and the associated components form a microprocessor supervisor circuit that provides two power-on reset lines for the logic circuits on the Display/DSP Board. See sheet 8 of the Display/DSP Board schematic. One is an active-low logic reset line and the other is an active-high reset line. At power-up, this circuit ensures the three regulated supplies (1.8 V, 3.3 V, and 5 V) are stable before it releases the board, and thus the entire control head, from reset. It will also reset the board if any of the three regulated power supplies fall below preset voltage thresholds. The power-up reset time period is typically less than 500 milliseconds. Integrated circuit U19 is the key component.

U19 is a Texas Instruments TPS3307 (or equivalent) triple microprocessor supervisory IC. Located on the secondary side of the board, near 16-contact flex-strip connector J9, it has an 8-pin Micro-Small Outline Package (MSOP) surface-mount case.

At control head power-up, after all three regulated power supplies rise above preset threshold voltages, U19 holds its two reset outputs in their active states for an additional 200 milliseconds. This includes the active-low reset output at U19 pin 5 and the active-high reset output at U19 pin 6. The threshold for the 1.8 V supply is 1.68 V, the threshold for the 3.3 V supply is 2.93 V, and the threshold for the 5 V supply is 1.63 V.

During control head power-up/reset, the active-low reset output at U19 pin 5 holds the Display/DSP Board's active-low RESET_N line (TP84) in a low state (below 0.5 V) via Schottky diode D17. The asserted state of RESET_N holds the Display/DSP Board's digital logic in reset. This includes the DSP U9-related circuits shown on sheet 5 of the schematic, and the display-related circuits shown on sheet 10. RESET_N is also applied to an input pin of CPLD U22 shown on sheet 9 of the schematic. This allows U22 to reset its internal logic and to synchronously generate the board's active-high RESET logic line which resets ACE U23, also shown on sheet 9.

When not in a reset condition, U19 pin 5 remains high and U19 pin 6 remains low. Therefore, pull-up resistor R128 holds active-low reset line RESET_N high (greater than 3 volts), so the board's digital logic circuits run normally. Also, U19 pin 6 holds the POREST line low. This drives the active-low output-enable input at octal buffer U25 pin 1 low so this buffer can latch data bytes on the data bus when required. U25 is shown on sheet 9 of the Display/DSP Board schematic.

4.1.6 24 MHz, 14.7456 MHz, and 12.288 MHz Clocks

The Display/DSP Board has a crystal-based reference oscillator that generates a 24 MHz reference clock for the entire board. This oscillator directly clocks the board's CPLD and an on-board clock generator. The clock generator has internal phase-locked loops that generate 12.288 MHz and 14.7456 MHz clocks from the 24 MHz clock. The 14.7456 MHz clock output clocks the board's display controller and the ACE, and the 12.288 MHz clock output clocks the board's CODEC.

Y2 is the Display/DSP Board's crystal-based reference oscillator. See sheet 9 of the schematic. It is located on the secondary (rear) side of the board, near 16-contact flex-strip connector J9.

Y2 drives the board's MCLK master clock line via R134 at Y2 output pin 3. Pin 3 also drives the clock generator's input at U37 pin 1 via R139. The board's 3.3 V regulated supply, 3.3 V line, powers Y2 via the 3.3V-OSC38 decoupled supply line. Since 3.3 V powers down when the control head is off, so does this oscillator. The MCLK master clock line clocks DSP U9 via its clock input at U9 pin 77. DSP U9 is shown on sheet 5 of the Display/DSP Board schematic.

U37 is a factory-programmed clock generator that contains an internal phase-lock loop circuit and flash-programmable dividers. It is mounted on the primary side of the Display/DSP Board, near CODEC U7.

U37 generates 12.288 MHz and 14.7456 MHz clocks from the board's 24 MHz reference clock. The outputs at U37 pins 7 and 8 drive the VFD_CLK and UART_CLK lines at 14.7456 MHz. The output at U37 pin 9 drives CODEC_CLK at 12.288 MHz. VFD_CLK drives the clock input of display controller U27 (OSC1 pin 11) via R137. U27 is shown on sheet 10 of the Display/DSP Board schematic. UART_CLK drives the clock input of ACE U23 shown on sheet 9 of the schematic (XTAL1 pin 50). CODEC_CLK drives the clock input of CODEC U7 shown on sheet 4 of the schematic (MCLK pin 22). U37 is housed in a 16-pin TSSOP-type surface-mount package.

4.1.7 Digital Signal Processor (DSP)

DSP U9 is the "brain" of the Display/DSP Board. It performs both the central processing unit (CPU) functions and digital signal processor (DSP) functions for the control head. It receives messages from and transmits messages to the mobile radio via the CAN link interface. It also performs speech compression/encoding for the microphone audio signals and speech decompression/decoding for demodulated receive audio signals. Speech compression/decompression algorithms include AMBE® for OpenSky radio networks, and IMBE™ for EDACS/ProVoice™ and Project 25 (P25) radio networks. It is the main processor on the board, performing all controlling functions for the control head per firmware flashed into its internal flash memory. See sheet 5 of the schematic.

CH-721 operating firmware is flashed into U9 at the factory. This firmware can be manually flash-updated via the control head's serial port if required. In addition, the connected mobile radio can be programmed to automatically send new CH-721 firmware to the control head via the CAN link.



NOTE

CH-721 control head flash updates via the CAN link are only supported in the OpenSky Trunking Protocol (OTP) mobile radio application.

DSP U9 has 1.8 V core logic and 3.3 V interface logic. Voltage-regulated DC power is delivered to U9 from the respective voltage regulator circuits described in 4.1.3.1 and 4.1.3.2.

DPS U9 is clocked at a 24 MHz rate via the MCLK line applied to U9 pin 77. MCLK is driven by crystal-based reference oscillator Y2. See sheet 9 of the schematic and Section 4.1.6 for additional information.

At control head power-up/reset, RESET_N provides an active-low reset pulse to U9's reset input at U9 pin 160. As shown on sheet 8 of the schematic, RESET_N is driven by logic within triple microprocessor supervisory U19, via one diode in dual Schottky diode D17 (TP84).

DSP U9 has a 19-bit address bus for addressing on-board memory and I/O logic. The lowest three (3) bits of this bus are used to address registers within Asynchronous Communication Element (ACE) U23, shown on sheet 9 of the schematic.

DSP U9 also has an 8-bit bidirectional data bus. On the Display/DSP Board this bus is used to read and write data bytes to ACE U23, read data bytes from the 8-bit transceiver in the 8-bit input port, and write data bytes to the 8-bit latch in the 8-bit output port.

4.1.8 8-Bit Input Port

Shown near the bottom of sheet 9 of the schematic, an 8-bit input port is formed by 8-bit latch U24 and pull-up resistor network RN3. 8-bit transceiver U24 is a 20-pin surface-mount IC located on the secondary (rear) side of the Display/DSP Board, near DSP U9. This port interfaces the eight respective active-low input lines to DSP U9's 8-bit bidirectional data bus. When an input is in the inactive state (logic high), the respective resistor in RN3 pulls the U24 pin high. See Table 4-1 below for additional information on each logic input line.

Table 4-1: Display/DSP Board's 8-Bit Input Port at U24

U24 PIN	DISPLAY/DSP BOARD SIGNAL NAME	FROM DISPLAY/DSP BOARD	NOTES
18	PTT	J5 pin 31 (schematic sheet 6)	Primary push-to-talk active-low input line from Keypad Board's mic connector (J2 pin 8). See Table 4-3.
17	ALT_PTT	J5 pin 32 (schematic sheet 6)	Alternate push-to-talk active-low input line from Keypad Board's mic connector (J2 pin 9). See Table 4-3.
16	CG_DISABLE	J5 pin 33 (schematic sheet 6)	Channel Guard disable active-low input line from Keypad Board's mic connector (J2 pin 10). See Table 4-3.
15	HANGUP	J5 pin 33 (schematic sheet 6)	Hang-up active-low input line from Keypad Board's mic connector (J2 pin 11). See Table 4-3.
14	Power_SENSE	J8 pin 13 (schematic sheet 7)	Active-low power sense input. Pulled low by a transistor on the Remote Interface Board when control head's ignition sense input line is on <u>and</u> control head's on/off switch is on. (Remote-control applications only.)
13	INPUT1	J8 pin 14 (schematic sheet 7)	See pin 22 of Table 4-4: Auxiliary Connector Pin-Out (DB-25 on Rear Panel)
12	INPUT2	J8 pin 15 (schematic sheet 7)	See pin 9 of Table 4-4: Auxiliary Connector Pin-Out (DB-25 on Rear Panel)
11	HKSW	J9 pin 16 (schematic sheet 7)	Hook switch active-low input line from pin 23 at DB-25 accessory connector. Pulled low (to near 0 Vdc) by an external switch.

4.1.9 8-Bit Output Port

Shown near the bottom of sheet 9 of the schematic, an 8-bit output port is formed by 8-bit latch U25 and pull-up resistor network RN4. 8-bit latch U25 is a 20-pin surface-mount IC located on the secondary (rear) side of the Display/DSP Board, near DSP U9. This port interfaces the eight respective output lines to DSP U9's 8-bit bidirectional data bus. When an input is in the high state, the respective resistor in RN4 pulls the U25 pin to near 5 V. See Table 4-2 that follows for additional information on each output logic line.

Table 4-2: Display/DSP Board's 8-Bit Output Port at U25

U25 PIN	DISPLAY/DSP BOARD SIGNAL NAME	TO DISPLAY/DSP BOARD	NOTES
19	12V_PWR_EN_OUT	J8 pin 12 (schematic sheet 7)	Active-high enable line to speaker audio amplifier circuit on Remote Interface Board. When in a low state (less than 0.5 Vdc), the speaker audio amp IC on the Remote Interface Board (U3) mutes and remains in a standby/low-current consumption state.
18	MUTE_10W_AUDIO	J10 pin 3 (schematic sheet 6)	Active-high mute control logic line to speaker audio amplifier circuit on Remote Interface Board. Normally remains in a low state (less than 0.5 Vdc).
17	KEYPAD_GRN	J5 pin 37 (schematic sheet 6)	Microphone's DTMF keypad backlight on/off control logic output. 0V turns backlight off and 3V turns backlight on. See Table 4-3 on page 29 for additional information.
16	VOL_ATNN	Base of Q1 (schematic sheet 4)	In a CAN-based radio, set high (greater than 3 volts) to increase attenuation of VOLHI attenuator/buffer stage. See Section 4.1.11.2 on page 27 for additional information.
15	FPROG	Gate of Q8 (schematic sheet 7)	Used during flash programming operations at the factory.
14	12V_PWR_LATCH	J8 pin 16 (schematic sheet 7)	Logic output to the Remote Interface Board. Controls switched A+ power line (SWA+) on the Remote Interface Board. Logically OR-ed with CNTLON by circuits on the Remote Interface Board.
13	(none)	Base of Q23 (schematic sheet 9)	Active-low headset speaker/earpiece mute control logic line for headset amplifier on the Display/DSP Board. Inverted by Q23.
12	RQST_CNTL	Base of Q22 (schematic sheet 7)	Used during flash programming operations at the factory.

4.1.10 Display, Display Controller and Display Power Supply

Display related circuits are shown on sheet 10 of the Display/DSP Board schematic. These circuits include the graphical dot-matrix vacuum fluorescent display (VFD), display control-related circuits, and a 43 V step-up switching power supply that provides anode power to the display. In addition, several transistors are used to switch the display's filament power and anode power on and off.

4.1.10.1 Display U26

Display U26 is a 140 x 32-dot matrix graphical dot-matrix vacuum fluorescent display (VFD) mounted on the primary side of the Display/DSP Board. It is a Noritake MN14032A (or equivalent) vacuum fluorescent display, and it is the Display/DSP Board's single largest component. The entire display measures approximately 3.8 inches long by 1.4 inches in height and 0.25 inches in depth (less connection pins). The actual 140 x 32-dot matrix display area measures approximately 2.75 inches by 0.85 inches. It can operate in either a three- or a four-text-line mode with simulated 5 x 7-dot characters, and with graphical-based characters such as a volume-level symbol/icon. However, most applications use a 3-text-line mode where the two upper lines have slightly larger characters than the lower line.

Display controller U27 (described in the next section) writes display-related data to two 240-bit shift registers within U26. This is accomplished via a 3-line synchronous serial interface between the two components. A 240-bit display driver circuit within U26 then reads the shift-register-stored-data to turn the respective dots in the display on and off as needed.

For the 3-line synchronous serial interface, the connection between display controller U27 pin 48 and U26 pin 15 is the clock line, the data line is the U27 pin 50 to U26 pin 14 and 17 connection, and the latch/strobe line is the U27 pin 38 to U26 pin 11 connection. Pulse activity occurs on these three lines whenever displayed characters change.

Filament power for display U26 is sourced from the Display/DSP Board's 5 V power supply line, identified 5 V on the schematic. R144, R145, R149 and R150 at the U26's filament pins are current-limit resistors that drop the 5 V DC power to approximately 3.4 volts across the filament terminals. C129 and C130 near U26 provide decoupling and filtering functions for the 5 V supply line. Filament current is approximately 230 milliamps. Normally, the filament power always remains on but an output from display controller U27 can turn it off by turning off N-channel MOSFET Q13 which provides the ground-path connection. The logic output at U27 pin 39 normally remains in a high logic state (greater than 4 volts). This state keeps Q13 on so its drain remains near ground potential. Refer to Section 4.1.10.4 (page 26) for circuit analysis information on the on/off switch at the output of the 43 V power supply.

4.1.10.2 Display Controller U27

Display controller U27 is a pre-programmed 16-bit single-chip microcomputer that interfaces vacuum-fluorescent display U26 to DSP U9. It is a Renesas Technology Corp. (formerly Hitachi Semiconductor) H8-family HD64F3672FP integrated microcomputer. U27 is located on the primary side of the Display/DSP Board under the display U26, and it has a 64-pin low-profile surface-mount package. U27 has a 16k byte Read-Only Memory (ROM) that stores its firmware operating program, and a 2k byte Random-Access Memory (RAM) that the program uses as scratch-pad memory. U27 is a 5 V device. It is powered by the Display/DSP Board's 5 V power supply. See sheet 10 of the Display/DSP Board schematic.

U27 receives data messages from DSP U9 via a 2-line asynchronous serial interface between the two integrated circuits. These messages include display character information and display control-related data such as power on/off. Inside U27, a Serial Communications Interface (SCI) handles interface functions, as controlled by U27's internal processor and stored firmware program. U27 converts these data messages to corresponding display data and sends the data to display U26 via the 3-line synchronous serial interface.

For the 2-line asynchronous serial interface, two logic gates perform logic-level conversions between the 3.3 V logic levels on the U9 side of the interface and the 5 V logic levels on the U27 side. This includes 3-state buffer U30 at U27 pin 46 for receive data line VFD_RX, and OR gate U29 at U27 pin 45 for transmit data line VFD_TX. Buffer U30's output is always enabled since its active-low output-enable input is grounded. Serial data on VFD_RX are handshaking-related data signals. OR gate U29 is wired as a buffer by grounding one of its inputs.

At control head power-up/reset, the Display/DSP Board's active-low RESET_N line provides a reset pulse to U27. RESET_N originates from the reset circuit shown on sheet 8 of the schematic (U19 pin 5, TP84, etc.) At power-up, the reset time is typically less than 500 milliseconds. Refer to Section 4.1.5 (page 20) for additional circuit analysis information.

The VFD_OSC clock line clocks U27 pin 11 via R137. VFD_CLK is driven by an output from clock generator U37. U37 is shown on sheet 9 of the schematic. See Section 4.1.6 on page 21 for additional information on U37.

4.1.10.3 Display 43 V Step-Up Switching Power Supply

Display U26 requires a 43 VDC power source for its anode supply. This power is provided by an on-board 43 V step-up switching power supply. It generates a regulated 43 V power source from the board's 5 V regulated power supply, and it can deliver up to 600 milliwatts of DC power to the display. Switching frequency is approximately 100 kHz. The circuit is shown at the bottom of sheet 10 of the schematic. It is located on the primary side of the Display/DSP Board, under display U26.

Integrated circuit U28 is the key component in this step-up switching power supply. It is an NJM2377M pulse-width modulated (PWM) switching regulator controller housed in an 8-pin surface-mount package. Other semiconductors include output MOSFET switch Q14, two dual rectifier diodes in the supply's output voltage doubling stage, and several bi-polar digital transistors (bi-polar transistors with internal bias resistors) used to switch the supply power on and off.

U28 pin 5 receives DC operating power from the board's 5 V regulated supply line. This supply line also feeds one side of the step-up switching supply's output inductor, L13 located between U28 pin 5 and Q14's drain. Supply input-side filtering and decoupling is provided by C136, C137 and C141. Maximum 5 V DC input current is approximately 150 milliamps.

U28 has an internal oscillator. C134 and R157 at U28 pin 7 set this oscillator's frequency to approximately 100 kHz. R159 provides a slight positive bias to pin 8 from the constant-current source output at U28 pin 6. As described later, this pin is also used for power supply soft-start functionality as controlled by the output at U27 pin 39, and digital transistors Q16 and Q17.

Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET) Q14 is the switching supply's output switch. It is an N-channel MOSFET. U27's internal totem-pole output at pin 4 drives Q14 via R161. Q14 and inductor L13 operate in a boost converter mode. When Q14 turns off, back-EMF from L13, along with the voltage-doubling network formed by D14, D15 and the associated capacitors, charge output filter capacitor C180. C138 provides decoupling and RF bypassing functions.

U28 pin 1 monitors the supply's output at filter cap C180 using the voltage divider formed by R169, R175 and R176. When regulated, the feedback voltage at pin 1 is 0.52 volts. This voltage is determined by the 0.52 V voltage reference within U28 and the closed-loop action of the complete regulator circuit. If the output is below 43 volts, pin 1 is below 0.52 volts so U28 increases Q14's on-time duty cycle time to boost the output voltage back up to 43 volts. The supply's output voltage at C180 typically ranges between 43 and 44 volts.

4.1.10.4 Display Power On/Off Switches

Digital transistors Q15 through Q17 are controlled by the same logic output from display controller U27 that is used to switch the display's filament power on and off: U27 pin 39. During normal display operation, this output always remains in a high state (greater than 4 volts) to turn on the filament and the 43 V regulated switching power supply. This high state saturates both NPN digital transistor Q17, which is used as a buffer-inverter stage for the logic line, and PNP digital transistor Q15 at the output of the 43 V power supply. Q15 is the supply's output on/off switch. Simultaneously, NPN digital transistor Q16 remains off, allowing switching regulator controller U28 to operate since its current-source pin is not held at ground potential. With Q15 saturated, regulated 43 V output power at C180 can feed the display's anode power supply input pin at U26 pin 6 (VDD2). C147 at Q15's collector is the filter cap for the anode supply, and R172 is a bleed-off resistor. A voltage drop of between 0.1 and 0.3 V across series resistor R158 indicates proper display anode current. For circuit analysis information on the filament supply on/off switch, see Section 4.1.10.1 (page 24).

4.1.11 Coder-Decoder (CODEC)

4.1.11.1 General Information

The Display/DSP Board's CODEC-related circuits are shown on sheet 4 of the schematic. Integrated circuits include 16-bit CODEC U7, linear voltage regulator U35, and op-amp U2.

CODEC U7 is a high-performance dual-channel 16-bit coder-decoder that performs digital-to-analog (D/A) conversions for receive audio signals from the radio (via the CAN link) and analog-to-digital (A/D) conversions for transmit audio signals from the microphone. It employs Sigma-Delta ($\Sigma\Delta$) conversion techniques at an 8 kHz sampling rate. U7 also performs other audio-related functions such as digital volume control in the receive audio path and mic audio gain control in the transmit audio path. Specifically, U7 is a Texas Instruments TLV320AIC20KIPFBR (or equivalent) integrated circuit housed in a 48-pin Thin Quad Flat-Pack (TQFP) surface-mount package. It is located on the primary side of the Display/DSP Board (same side as the display), near 40-pin dual-row header connector J5.

Digitized speaker and mic audio and control data pass between CODEC U7 and DSP U9 via a 4-line serial interface. This interface uses U9's Multi-Channel Buffered Serial Port (MCBSP) interface and U7's time-division multiplexed interface. See sheets 4 and 5 of the schematic. BCLK is the bit-clock line from U9 applied to U7 pin 20, FSYNC is the frame-sync line from U9 applied to U7 pin 19, MCBSP_DOUT is the data output line from U9 to U7 pin 18, and MCBSP_DIN is the data input line from U7 pin 17 to U9.

A 12.288 MHz master clock signal clocks U7 at pin 22 via the CODEC_CLK line. This clock line is driven by an output from clock generator U37. U37 is shown on sheet 9 of the Display/DSP Board schematic. It generates this clock and two other clocks from the board's 24 MHz main clock. Refer to Section 4.1.6 on page 21 for additional circuit analysis information.

Linear voltage regulator U35 provides DC bias to the front microphone input and the External mic input. Resistive voltage dividers are sourced to +9.55 VDC from U35 and provide a DC bias across each microphone input.

4.1.11.2 Receiver Audio Path for CAN-Linked Remote-Mount Mobile Radios

For a CAN-based remote-mount mobile radio such as the M7200, demodulated digitized receiver audio is routed to the control head via the CAN link between the radio and the control head. The digitized audio is then uncompressed by DSP U9 on the Display/DSP Board, and routed to the CODEC via U9's MCBSP interface. Digital-to-analog converter (DAC) circuits in the CODEC then convert the uncompressed digitized audio to corresponding analog audio signals.

CODEC U7 outputs the analog receiver audio analog signals at U7 pin 4 to drive the EXTERNAL_AUDIO signal line. This differential/balanced output drives the unbalanced EXTERNAL_AUDIO line. Signals on EXTERNAL_AUDIO are amplified by the speaker audio amplifier circuit located on the Remote Interface Board.

EXTERNAL_AUDIO is routed to the Remote Interface Board via pin 1 of Display/DSP Board flex-strip connector J10 (TP12). J10 mates with J8 on the Remote Interface Board. The EXTERNAL_AUDIO signal level is approximately 1.4 V RMS at maximum volume. For details on the speaker audio amplifier circuit, refer to Section 4.3.1 (page 31).

4.1.12 Asynchronous Communication Element (ACE)

Integrated circuit U23 on the Display/DSP Board is a quad (4-channel) Asynchronous Communication Element (ACE) that supports four (4) asynchronous serial ports for the control head. It is a Texas Instruments TL16C554AIPNR (or equivalent) device housed in a surface-mount package.

4.1.13 Headset Audio Outputs

4.1.13.1 At Front Panel Microphone Jack

The Display/DSP Board has a 1-watt audio amplifier circuit for speaker/earpiece elements in a headset connected to the control head via the mic jack on the front panel. This circuit is shown on sheet 1 of the schematic. It is formed by audio amp U31 and the associated components. U31 is housed in an 8-pin surface-mount package and it is located on the secondary (rear) side of the board, near 22-pin connector J8.

U31 operates on 5 V DC power as provided from the 5V supply line. L1 and the capacitors at U31 pin 6 provide low-pass filtering at U31's DC power input.

Low-level audio from CODEC U7 is delivered to the audio amp circuit via HEADSET_AUDIO. Capacitor C6 provides AC-coupling and high-pass functions for the input signal. R9 and R15 establish low-frequency signal gain, and C9 in the feedback loop sets the high-frequency roll-off point, preventing circuit oscillation.

Audio outputs HEADSET_SPKR+ and HEADSET_SPKR- are applied to the mic jack via Display/DSP Board connector J5 pins 28 and 30. These lines are identified SPEAKER_P and SPEAKER_N on both Keypad Board schematics.

4.1.13.2 At Rear Panel DB-25 Connector

To support a headset audio output at the rear panel, differential outputs from CODEC U7 pin 26 and 28 are routed through R188 and R193 to Display/DSP Board J8 pins 21 and 22. This SPKR_HI and SPKR_LOW headset output is limited to 35 milliwatts into 24-ohm headset. On the Display/DSP Board schematic, see sheets 4 (CODEC) and 7 (connector J8). On the Remote Interface Board schematic, see sheet 2. The differential headset audio output is applied to pins 18 and 19 of the auxiliary connector (DB-25) on the head's rear panel. See Table 4-4 for additional information.

4.2 KEYPAD BOARDS

There are two (2) different Keypad Boards. One is used in the Scan model CH-721 control head and the other is used in the System model CH-721 control head. Circuits on each board include button switch contacts, row-column matrix-scan interconnections for these contacts, backlighting LEDs, and driver logic for the LEDs. Additional Keypad Board circuits include three (3) buffers for the synchronous interface link between the DSP U9 on the Display/DSP Board and the respective Keypad Board's LED driver logic, ambient light level sensor circuit, and mic jack interconnections.

Table 4-3: CH-721 Control Head's Mic Jack Pin-Out Interconnections To/From Display/DSP Board

MIC JACK J2 PIN	CH-721 INPUT/OUTPUT	KEYPAD BOARD SCHEMATIC SIGNAL NAME	SIGNAL DESCRIPTION	CONNECTS TO DISPLAY/DSP BOARD J5 PIN	DISPLAY/DSP BOARD SIGNAL NAME
1	—	(none)	(Chassis Ground)	19 through 25 (except 21)	—
2	—	(none)			—
3	Input	MIC	Microphone audio input (high)	26	FRONT_MIC
4	Input	MIC_RET	Microphone audio input (low)	27	FRONT_RET
5	Output	SPEAKER_N	Headset audio output (common/negative)	28	HEADSET_SPKR-
6	Output	SPEAKER_N		29	HEADSET_SPKR-
7		SPEAKER_P	Headset audio output (high/positive)	30	HEADSET_SPKR+
8	Input	PTT	Active-low Push-To-Talk input	31	PTT
9	Input	ALT_PTT	Alternate PTT input	32	ALT_PTT
10	Input	CG_DISABLE	Active-low Channel Guard disable input	33	CG_DISABLE
11	Input	HANGUP	Hook switch input (low when mic on hanger)	34	HANGUP
12	Output	TXD	Serial transmit data output for mic's keypad logic interface	35	TXD
13	Input	RXD	Serial receive data input for mic's keypad logic interface	36	RXD
14	Output	KEYPAD_GRN	DTMF keypad backlight on/off control logic output (0V = lights off; 3V = lights on)	37	KEYPAD_GRN
15	Output	SWA+	Switched 12 V supply output to microphone for mic's keypad logic	38	12V_OUT
16	—	(none)	(Chassis Ground)	19 through 25 (except 21)	—
17	—	(none)			—

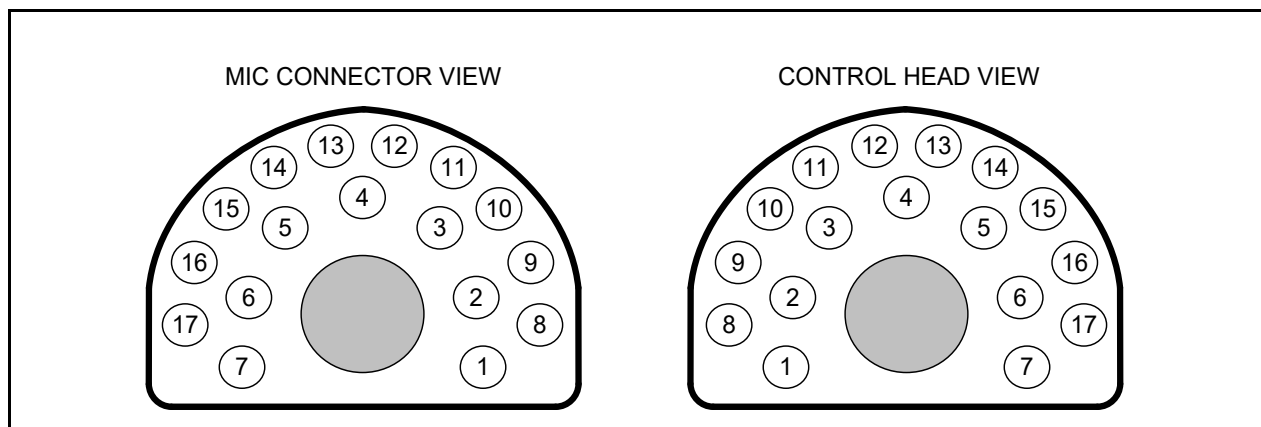


Figure 4-1: CH-721 Control Head Microphone Jack Pin-Out (J2 on Keypad Board)

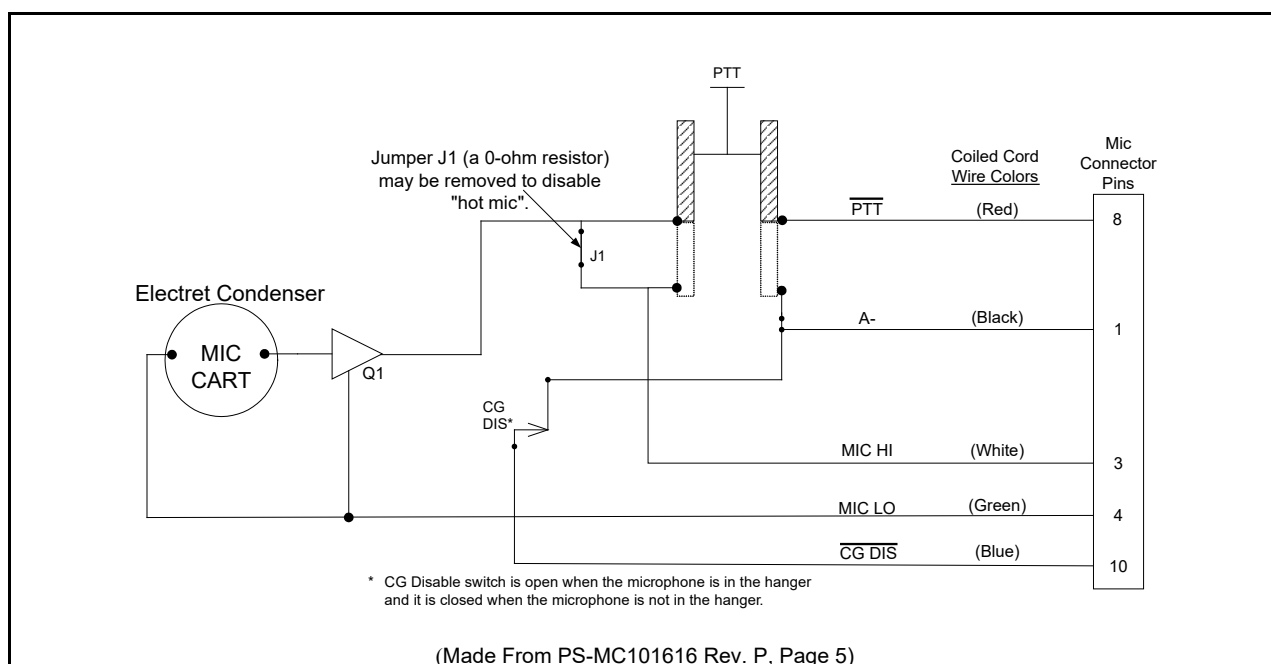


Figure 4-2: Internal Wiring of Standard Mic MC-101616-040

4.3 REMOTE INTERFACE BOARD

The Remote Interface Board is a part of the CH-721 Rear Housing Assembly used in remote-control applications. It includes circuitry to support a remote-mount radio installation. The respective Rear Housing Assembly is shown on page 73, and the board's circuits are described in the following subsections:

4.3.1 Speaker Audio Amplifier

The Remote Interface Board's speaker audio amp circuit amplifies low-power speaker audio signals from the Display/DSP Board to drive a speaker externally-connected to the CH-721. The rated audio output power is 15 watts. Speaker output connections are differential-type connections (i.e., not referenced to ground). Circuits include an active low-pass filter op-amp stage, an audio power amplifier stage, and muting logic. Mute logic is controlled by a logic output from the Display/DSP Board in the control head's Front Cover Assembly.

As shown on sheet 3 of the Remote Interface Board's schematic, low-level speaker audio signals from the Display/DSP Board are applied to the Remote Interface Board at 16-conductor flex-strip connector J8 pin 1. This audio input is identified as the EXTERNAL_AUDIO signal line. Maximum signal level on EXTERNAL_AUDIO is approximately 1.4 V RMS at maximum volume.

Audio signals on EXTERNAL_AUDIO are applied to an active low-pass filter stage formed by op-amp U2 as the associated components. This stage is shown on sheet 1 of the Remote Interface Board's schematic. U2 is an 8-pin MAX4246 (or equivalent) dual op-amp housed in a SOT23-8 surface-mount package. It is located on the front of the board near audio power amp U3. At the output of this stage, filtered signals at U2A pin 1 are AC-coupled to the input of audio power amp U3. Revision D (and later) hardware includes analog switch U2 at U3's input for muting. Revision C and earlier hardware utilizes a mute input (U3 pin 11) and mute logic within audio power amp U3.

All pins of U2A and U2B are DC biased at approximately 1.65 volts as determined by divider resistors R8 and R10 at the input of op-amp U2A, which is wired as a simple voltage-follower. Resistor R32 and capacitors C8 and C9 filter and decouple the 3.3 V power supply which powers this low-pass filter stage. C11 in U2A's feedback loops establishes the stage's overall frequency response.

Audio power amp U3 and associated components provide up to 15 watts of audio power to drive an external speaker connected to the control head's 2-pin AUDIO connector. As illustrated in Figure 3-3 on page 13, this 2-pin connector is located on the rear panel of the control head. Identified J2, it is shown along with audio power amp U3 on sheet 1 of the Remote Interface Board's schematic. The differential output connections of U3 are decoupled and surge-protected by the components shown on sheet 1 between U3 and J2.

U3 is a high-power audio amplifier IC in a single-in-line package. It is secured to the casting of the Rear Housing Assembly by a spring-clip.

Switched and filtered DC operating power is delivered to U3's DC power inputs from the board's on/off switch circuit. Typical DC voltage at these pins is between 12 and 14 volts. Maximum U3 DC current consumption is approximately 1.8 amps at a 15-watt speaker audio output level. When not being driven by audio signals, U3 has a quiescent current of less than 150 milliamps. Capacitors C3, C4 and C5 located near U3 provide supply filtering and decoupling functions for U3. See Section 2.1 on page 8 for DC requirements for the complete CH-721 in various operating modes.

U3 has a diagnostic output (pin 12 for revision C and earlier; pin 4 for revision D and later) that is applied to pin 4 of flex strip connector J8 via the DIAGNOSTIC_N line. This logic line is monitored by DSP U9 on the Display/DSP Board so it can take appropriate action during abnormal circuit operation. DIAGNOSTIC_N signals DSP U9 during periods of excessive distortion and/or excessive heat in U3 and/or a short circuit on a U3 speaker audio output. During normal audio amp operations, DIAGNOSTIC_N remains high (greater than 3 volts). Excessive distortion levels cause pin 12 to pulse, as controlled by a dynamic distortion detector within U3. A short on either speaker lead (to ground or to power) will cause DIAGNOSTIC_N to pulse. Excessive heat will cause pin 12 to transition and remain low (less than 0.5 volts) until U3 cools internally.

For board revision C and earlier hardware, the mode input at U3 pin 11 is used to mute the audio power amp during control head power-up. This prevents “pops” from occurring in the connected speaker at power-up. During normal operations, pin 11 remains greater than 8.5 Vdc as controlled by the 12V_PWR_EN line from flex strip connector J6 pin 12. This Remote Interface Board input is controlled by DSP U9 on the Display/DSP Board. Amplifier muting occurs when the Display/DSP Board pulls MUTE_10W_AUDIO high (greater than 3 volts), turning on Q8, thus pulling U3 pin 11 between approximately 3.3 and 6.4 Vdc (depending upon control head A+ input voltage).

For revision D and later hardware, muting is performed by single-pole single-throw analog switch U8. This switch is controlled by the 12V_PWR_EN and MUTE_10W_AUDIO lines via transistors Q4, Q7 and Q8. In addition, U3 includes internal power-up muting logic.

4.3.2 DC Power Input On/Off Switch

On the Remote Interface Board, a DC power on/off switch circuit is formed by high-side MOSFET driver U1 and the associated components. This circuit switches DC input operating power (typically 12 to 14 volts) at J1 pin 2 onto the switched A+ supply line identified SWA+. See sheet 1 of the Remote Interface Board's schematic. SWA+ supplies DC operating power directly to both the Display/DSP Board and to the speaker audio amp stage on the Remote Interface Board. This circuit also includes DC power conditioning/filtering, over-voltage protection, and reverse-voltage protection. As illustrated in Figure 3-3 on page 13, J1 is the 3-pin DC power input connector located on the rear panel of the control head.

A logic output from the Display/DSP Board, CNTLON at flex-strip connector J5 pin 7 (or DB-25 connector J7 pin 14), controls this switch circuit based upon user control of the control head's on/off/volume control and/or the status of the control head's control-on input at J7 pin 14. When the on/off/volume control is on (i.e., not in the off detent position) and the ignition sense input at J1 pin 3 (IGNA+) is powered, CNTLON sinks current from Q2's base. This keeps Q2, Q3 and U1 on so SWA+ remains powered from J1 pin 2 (the non-switched A+ power supply line). After turning on, DSP U9 on the Display/DSP Board latches the power on by pulling 12V_PWR_LATCH high (greater than 3 volts). This turns on Q5 and Q9, keeping the switch circuit on even after the on/off/volume control is turned to the off position. This allows DSP U9 to “gracefully” power down the control head by signaling the connected remote-mount mobile radio to save important settings.

Schottky power Rectifier diode D10 on the non-switched A+ DC input (at J1 pin 2) provides over-voltage protection and reverse-voltage protection for the control head. D10 clamps positive voltage potentials (referenced to ground) at approximately 40 volts, and negative voltage potentials at less than one-half volt.

4.3.3 Ignition Sense Interface

The Remote Interface Board has two (2) ignition sense inputs that allow the CH-721 to sense the on/off state of an external DC line such as that from a vehicle's ignition switch/key. The input at J1 pin 3 is used in most applications. The input at pin 10 of the 25-pin D-subminiature (DB-25) "Accessory" connector on the rear panel is provided for future applications of the CH-721.

When the ignition sense input is powered (typically at 12 volts) and the control head's on/off/volume control is on, Q2 remains on, thus supplying base current to Q6, which keeps it on also. See sheet 1 of the Remote Interface Board's schematic. This pulls the IGNITION_N line low (less than 1 V) via diode D8, driving flex-strip connector J6 pin 3 low also. DSP U9 on the Display/DSP Board reads this low state and acts accordingly by latching the Remote Interface Board's on/off switch on; see the previous section for additional information.

4.3.4 Serial Port Interface (DB-9 on Rear Panel)

The Remote Interface Board includes a TTL-to-TIA/EIA/RS-232 level converter to support the 9-pin serial port on the rear of the control head. This converter is wired to an ACE channel on the Display/DSP Board. This serial port is only active when the radio-to-control head CAN link is disconnected; otherwise, the serial port on the rear of the radio is active. See sheet 3 of the Remote Interface Board's schematic. This port is used during keypad key/button re-mapping configuration procedures (see Section 5.5 for additional information), and during test procedures performed at the factory.

Integrated circuit U6 is a RS-232 transceiver that contains five (5) drivers and three (3) receivers. Located on the front of the Remote Interface Board, it has a 28-pin TSSOP surface-mount IC package.

U6 is powered by the 3.3 V regulator on the Display/DSP Board via the 3.3V supply line. Charge-pump circuits in U6 along with capacitors C19, C21, C22 and C23 boost the 3.3V supply to RS-232 levels for the drivers inside U6.

4.3.5 CAN Port Interface

CAN port interface circuitry on the Remote Interface Board includes two 3-pin connectors that support external daisy-chaining of CAN links between the connected mobile radio and the control head(s). Other components include a double-choke (inductor) that provides suppression of asymmetrical noise signals on the CAN link, surge-protection components, and RF bypass capacitors. See sheet 2 of the Remote Interface Board's schematic.

As illustrated in Figure 3-3 on page 13, there are two 3-pin CAN port connectors on the rear panel of the CH-721 control head. These connectors are identified J3 and J4 on the Remote Interface Board. Double-choke L6 interconnects the CAN_HI and CAN_LO lines at J3 and J4 to pins 10 and 11 of 16-conductor flex-strip connector J5. A 16-conductor flex-strip connector interconnects J5 to J9 on the Display/DSP Board. Surge protection is provided by four diodes within D1 at J3 and J4.

4.3.6 Auxiliary Connector Interface (DB-25 on Rear Panel)

The CH-721 control head's auxiliary connector is the 25-pin D-subminiature (DB-25) connector on the rear panel of the head. Related interconnections include those to support siren/PA interface functionality, an RS-232 serial port, an RS-485 serial port (not used), and several input and outputs for miscellaneous use. The siren/PA interface requires CH-721 control head firmware SK-011241-001 release R02A06 (or later). The connector's pin-out is listed in the following table:

Table 4-4: Auxiliary Connector Pin-Out (DB-25 on Rear Panel)

PIN	REMOTE INTERFACE BOARD SIGNAL NAME	CH-721 INPUT OR OUTPUT	NOTES
1	(Ground)	—	Chassis ground. Same as pin 7.
2	RTS	Input	Request-To-Send (RTS) input of secondary TIA/EIA/RS-232 serial data interface port. Port operation not supported.
3	XDATAOUT	Output	Port operation not supported.
4	RS485-	Bi-Directional	Port operation not supported.
5	RS485+	Bi-Directional	
6	CTS	Output	Port operation not supported.
7	(Ground)	—	Chassis ground. Same as pin 1.
8	CUTST	Output	Digital output used during flash programming operations at the factory. 0-to-5 V logic. Referenced to chassis ground (pins 1 and 7).
9	INPUT2	Input	Digital input 2. 0-to-5 V logic. Configurable for various uses via the Radio Personality Manager (RPM). Surge-protected. Referenced to chassis ground (pins 1 and 7). For OpenSky running OTP software R18C or earlier, send AT@PTT_AUX_INPUT2 to the radio to select only this input for auxiliary PTT control. Send AT@PTT_AUX_INPUT3 to select both this input and the INPUT1 (pin 22) for auxiliary PTT control. Send AT@PTT_AUX_INPUT0 to disable all CH-721 auxiliary PTT inputs. For OpenSky running OTP software R18D or later, send AT@AUXIO3,1,0,1,1 to the radio to set this input for non-emergency auxiliary PTT control. Using a “1” as the last digit of this command pairs this input as PTT control for the external mic input at Pin 24. Send AT@AUXIO1,0 to disable this input. Additional addressable functions are available, such as defining this input as an emergency function input. Refer to the OpenSky MES Command Manual: MM-016649-001 or contact the Technical Assistance Center.
10	IGNA+	Output	Switched DC output. Equal in voltage to the voltage of the ignition sense input battery power (typically 12 to 14 V DC). Referenced to chassis ground (pins 1 and 7).
11	MIC_HI	Output	Public Address (PA) differential audio output for connecting to a siren and light system (e.g., Federal Signal SmartSiren® SS2000), or external PA amp. [Pin 11 to SS2000's DB-9 pin 5; pin 12 to DB-9 pin 6].
12	MIC_LOW	Output	
13	VOLHI	Input	Not supported/not used.
14	CNTLON	Bi-Directional	Parallel to operation of control head's on/off volume control. As an output, high (>2.5 volts) when control head is on (1 milliamp maximum). As an input, Low turns control head and radio on. Referenced to chassis ground (pins 1 and 7).
15	SONOFF	Output	In a remote-mount radio installation, this pin for the siren/PA interface is the siren on/off logic output (open-collector). It is the signal that turns the connected third-party siren and light system on and off. Referenced to chassis ground (pins 1 and 7). [To SS2000's DB-9 pin 4].
16	SDATA	Output	In a remote-mount radio installation, this pin for the siren/PA interface is the siren serial data output (open-collector/open-drain). It serially transfers siren and light control data from the CH-721 to a connected third-party siren and light system. Data rate = 1200 bps. Referenced to chassis ground (pins 1 and 7). [To SS2000's DB-9 pin 3].
17	RS485_RQST	Output	Port operation not supported/not used.
18	SPKR_HI	Output	

Table 4-4: Auxiliary Connector Pin-Out (DB-25 on Rear Panel)

PIN	REMOTE INTERFACE BOARD SIGNAL NAME	CH-721 INPUT OR OUTPUT	NOTES
19	SPKR_LOW	Output	Low-power high-impedance (approximately 200-ohm) differential speaker audio output. For OpenSky, send AT&AO1 to the radio to send audio to this output and disable main speaker audio output. Send AT&AO to the radio to disable this audio output and send audio to main speaker audio output.
20	XDATAIN	Input	Port operation not supported.
21	HORNRI	Input	In a remote-mount radio installation, this pin for the siren/PA interface is the horn/ring input. When a connected third-party siren and light system has its horn/ring function active, this control head input is used to signal the control head as such. Referenced to chassis ground (pins 1 and 7). [To SS2000's DB-9 pin 8].
22	INPUT1	Input	Digital input 2. 0-to-5 V logic. Configurable for various uses via the Radio Personality Manager (RPM). Surge-protected. Referenced to chassis ground (pins 1 and 7). For OpenSky running OTP software R18C or earlier, send AT@PTT_AUX_INPUT1 to the radio to select only this input for auxiliary PTT control. Send AT@PTT_AUX_INPUT3 to select both this input and the INPUT2 (pin 9) for auxiliary PTT control. Send AT@PTT_AUX_INPUT0 to disable all CH-721 auxiliary PTT inputs. For OpenSky running OTP software R18D or later, send AT@AUXIO2,1,0,1,1 to the radio to set this input for non-emergency auxiliary PTT control. Using a "1" as the last digit of this command pairs this input as PTT control for the external mic input at Pin 24. Send AT@AUXIO0,0 to disable this input. Additional addressable functions are available such as defining this input as an emergency function. Refer to the OpenSky MES Command Manual: MM-016649-001 or contact the L3Harris Technical Assistance Center.
23	HKSW	Input	External microphone hookswitch input. 0-to-5 V logic. Logic low (< 0.5 V) = on-hook. Surge-protected. Referenced to chassis ground (pins 1 and 7).
24	EXT_MIC	Input	External microphone audio input. Typically, used for headset connections. Referenced to chassis ground (pins 1 and 7). For OpenSky running OTP software R18C or earlier, send AT@MIC_REAR_INPUT0 to enable. For OpenSky running OTP software R18D or later, refer to the notes for Pins 9 or 22. Refer to the OpenSky MES Command Manual: MM-016649-001. For OpenSky running OTP software R19A, send AT@DEFAULT_MIC_INPUT1 to enable this mic input on the primary/first control head. (AT@DEFAULT_MIC_INPUT0 sets it for the front panel mic connector.)
25	SWA+	Output	Switched DC output. When CH-721 control head is on, approximately equal in voltage to that of the battery power applied control head's main power input (typically 12 to 14 V DC). Referenced to chassis ground (pins 1 and 7).

5 MAINTENANCE

5.1 GENERAL INFORMATION

For technical assistance, contact the Technical Assistance Center using the contact information listed in Section 6.

5.2 PREVENTIVE MAINTENANCE



Always ensure the control head is protected from possible damage.

- Install and protect the control head(s) to avoid direct impact from water and hose-down, snow, dust, smoke, gases, road debris, oils, chemicals and corrosive agents.
- Use splash guards, shields, or covers to protect the control head from direct impacts.

Preventive maintenance on the control head installation should be performed periodically. L3Harris recommends performing preventive maintenance on an annual basis, or more often in harsh environments such as an installation in a fire truck or motorcycle. At a minimum, preventive maintenance should include:

- Inspecting all control head related hardware to verify it is in place and securely tight. Any missing or loose hardware should be replaced and/or tightened as necessary.
- Inspecting all cabling to verify it is not damaged, it is securely tied-and-stowed, and all related cable connectors are tight. Repair as necessary.
- Verifying overall radio operation by performing an operations check.

5.3 CLEANING

Keep the exterior of the control head and radio accessories clean. Periodically clean them using either the light-duty cleaning procedure or in extreme cases the heavy-duty cleaning procedure.

5.3.1 Light-Duty Cleaning Procedure

The following general cleaning procedure is recommended for light-duty cleaning:

1. To remove dust and dirt, use a soft dry brush to remove the excess dust and then use a clean damp cloth (warm water and mild detergent soap, or Simple Green).
2. Follow by wiping with damp (warm water) clean cloth.
3. Wipe dry with clean cloth.



Do not use chemical cleaners, spray, or petroleum-based products. They may damage the control head's housing. For light cleaning, use soap and water or Simple Green. For disinfecting, Calla 1452 can be used.

5.3.2 Heavy-Duty Cleaning Procedure

Calla 1452 or equivalent is recommended for heavy-duty cleaning. For more rigorous cleaning, use the following procedure:

1. Apply the cleaning solution to a clean damp cloth and clean the control head.



Do not spray cleaning solution directly on control head.

2. Wipe off the control head with clean damp cloth using mild warm soapy water.
3. Follow up by wiping off the control head with clean damp cloth using warm water only.
4. Wipe dry with clean cloth.

5.4 DISASSEMBLY AND REASSEMBLY PROCEDURES

This section includes disassembly and reassembly procedures for the CH-721 Scan and System model control heads. A list of tools required to perform the procedures is included.



Observe precautions for damage due to **Electro-Static Discharge (ESD)**. Always use proper grounding techniques (wrist or waist straps with grounding cords, grounded table-top mats, etc.) and other approved methods in order to minimize the chance of damage from ESD.

5.4.1 Tools Required

- T10 Torx® Screwdriver
- Two (2) Small Flat-Blade Screwdrivers (with 1/8-inch tip)
- #0 Phillips Screwdriver
- 5-Millimeter Nut Driver
- 5/8-Inch (or 16 millimeter) Nut Driver or Wrench²
- 1-Inch (or 26 millimeter) Nut Driver or Wrench²
- Torque Screwdriver with changeable #0 Phillips, T10 and 5 mm hex bits/tips, recently calibrated, and capable of the following torque setting: 1.4, 1.6, 4.4 and 6.0 inch-pounds
- Small Needle-Nose Pliers
- Thermal Heat-Transfer Compound: Dow Corning® 340, or Shin-Etsu KS-609, or equivalent
- ESD-Safe Workplace, Wrist or Waist Strap with Grounding Cords

² The 5/8-inch and 1-inch nut drivers/wrenches are only required for removing/installing the Remote Interface Board from the Rear Housing Assembly.

5.4.2 Local-Control Control Head/Front-Mount Radio Only



When separating or mating the control head and radio, always use caution to avoid damaging the silicon-rubber-based perimeter gasket and the flex strip inside the radio's front cavity. If using a prying tool, use caution to avoid damaging the gasket and internal components. Do not pull on or twist the flex strip.

5.4.2.1 Separating the Control Head from the Radio

If the local-control CH-721 control head is part of a front-mount mobile radio, use this procedure to separate the control head from the radio:

1. Place the radio on a flat ESD-safe surface, in a bottom-up position.
2. Using a T10 Torx screwdriver, loosen and remove the two (2) screws located just behind the control head (in the radio casting).
3. While slightly lifting the front portion of the radio casting off the ESD-safe surface, gently pivot the control head out from the radio casting.
4. Carefully disconnect the flex strip between the control head and the radio by disconnecting it at the radio's PK Board connector (which extends into the rectangular hole at the front of the casting).

Lift/hinge the connector's latch until it is approximately perpendicular with the board, and then gently extract the end of the flex strip from the connector.

5.4.2.2 Mating the Control Head to the Radio

Follow this procedure to mate a local-control CH-721 control head to a front-mount mobile radio. It is assumed the radio and control head are each completely assembled:

1. Place the radio on a flat ESD-safe surface, in a bottom-up position.
2. Install a silicon-rubber-based perimeter gasket, FM-013354, at the front of the radio's casting, if not already installed.



Do not confuse the perimeter gasket with the gasket between the control head's Front Cover Assembly and Rear Housing Assembly. The two gaskets are not the same.

3. Place the control head on the ESD-safe surface just in front of the radio's casting so the rear of the head is facing the front of the radio casting, and it is in a bottom-up position.
4. Mate the flex strip from the rear of the control head to the PK Board flex strip connector.

The radio's PK Board flex strip connector extends slightly out of the rectangular hole in the front cavity of the radio casting. Upon mating, verify the strip's contact surface is up and the stiffener surface (typically blue in color) is down (and directly adjacent to the connector's latch). This assumes the radio and head are still bottoms-up. After fully inserting the flex strip into the connector, be sure to completely lock-down the connector's latch.

5. While slightly lifting the front portion of the radio casting off the ESD-safe surface, gently pivot the top of the control head into the front cavity of the radio casting, and then hinge the rear of the control head completely into the cavity.

6. While pressing the head firmly to the radio, install the two (2) M3 x 5 millimeter black-anodized Torx drive screws into the holes located just behind the control head (in the radio casting).
7. Using a torque screwdriver with a T10 bit/tip, tighten these two screws to 6.0 inch-pounds (± 0.5 inch-pound).

5.4.3 Separating the Front Cover Assembly from the Rear Housing Assembly and Removing the Display/DSP Board

Separate the Front Cover Assembly from the Rear Housing Assembly in accordance with this procedure:

1. Place the control head on a flat ESD-safe surface, in a rear-facing position.
2. Using a T10 Torx screwdriver, loosen the four (4) T10 stainless-steel screws near each corner of the Rear Housing Assembly. These are captive screws, so complete removal is not required. See Figure 5-1.
3. Separate the Rear Housing Assembly from the Front Cover Assembly by gently pulling the two apart. Typically, this can be accomplished without any tools. However, in rare cases, a small prying tool may be required.



When separating or mating the Front Cover Assembly to the Rear Housing Assembly, use caution to avoid damaging the silicon-rubber-based perimeter gasket (typically blue in color), flex strips, printed circuit boards, and other components inside the head. Do not pull on or twist the flex strips! If using a prying tool, use caution to avoid damaging the gasket and internal components.

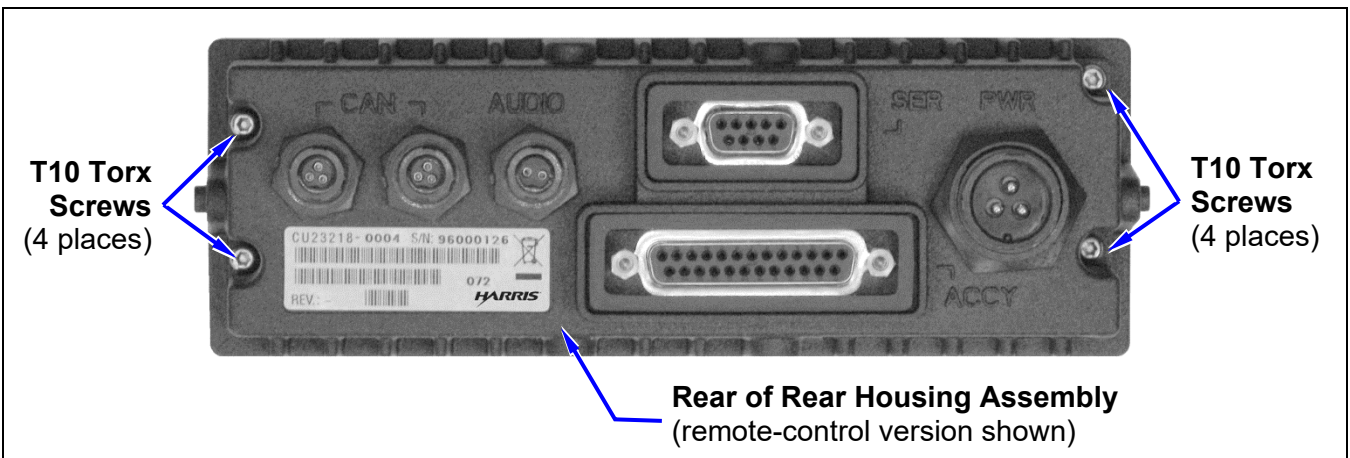


Figure 5-1: Separating/Mating Front Cover Assembly and Rear Housing Assembly (Torx Screws at Rear)

4. Remote-Control Control Head Only: As illustrated in Figure 5-2, carefully disconnect the three (3) front-to-rear flex strips at the Display/DSP Board by lifting/hinging each connector's latch until it is approximately perpendicular with the board, and then gently extracting the end of the respective strip from the connector.
5. Local-Control Control Head Only: Although not illustrated, the local-control version of the control head has only one (1) front-to-rear flex strip. It mates with the radio's PK Board. See Section 5.4.2.1 on page 38 for separation instructions.

6. Disconnect the control knob's flex strip by sliding the connector's latch out in a direction parallel with the board, and then gently extract the contact end of the strip from the connector.
7. Remove the Display/DSP Board from the Front Cover Assembly. No screws secure it in the assembly now. Gently lift the board straight up and out of the assembly to avoid damaging the board-to-board type connector on the display side of the board. This connector mates to a similar type connector on the Keypad Board. At this point in the disassembly process, the Keypad Board is still secured within the Front Cover Assembly by a shield and small screws.

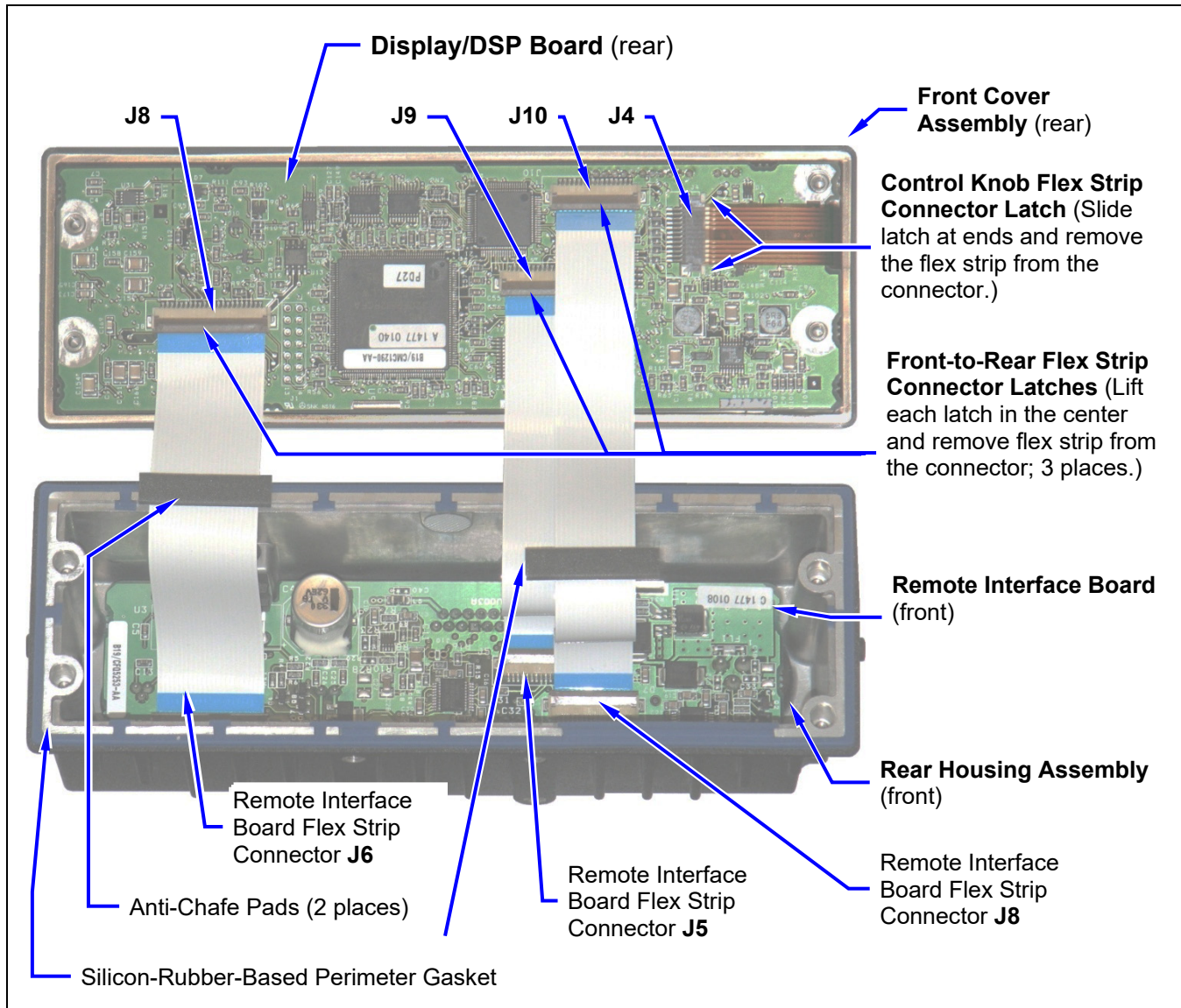


Figure 5-2: Separating/Mating Front Cover Assembly and Rear Housing Assembly (Disconnecting/Reconnecting Flex Strips)

5.4.4 Installing Display/DSP Board and Mating the Front Cover Assembly to the Rear Housing Assembly

The following procedure is recommended to mate the Front Cover Assembly to the Rear Housing Assembly:

1. Place the two assemblies on a flat ESD-safe surface, with their inside portions facing up. Figure 5-2 illustrates this for the remote-control version of the control head.
2. Inspect the silicon-rubber-based perimeter gasket at the front edge of the Rear Housing Assembly for any defects (tears, cracks, etc.). If any defects are found, obtain a new gasket.
3. Install the gasket at the front edge of the Rear Housing Assembly, if not already installed. See Figure 5-2.
4. Remote-Control Control Head Only: In the Rear Housing Assembly, mate the shortest 16-conductor flex strip to connector J5 on the Remote Interface Board. See Figure 5-2. This is the (narrower) flex strip without the anti-chafe pad.



When mating a flex strip to its respective connector, always position it in the connector housing with its contact surface towards the gold contacts in the connector and its stiffener surface (typically blue in color) towards the latch of the connector. Complete the mate by pressing the strip fully into the connector before locking the latch down.

5. Remote-Control Control Head Only: In the Rear Housing Assembly, mate the longest 16-conductor flex strip to connector J8 on the Remote Interface Board. This is the (narrower) flex strip with the anti-chafe pad.
6. Remote-Control Control Head Only: In the Rear Housing Assembly, mate the 22-conductor flex strip to connector J6 on the Remote Interface Board. This is the widest flex strip with the anti-chafe pad.
7. Verify all components, screws, standoffs on the inside corners, etc., are properly installed into the Front Cover Assembly.
8. Install the Display/DSP Board into the Front Cover Assembly, if not already installed. Carefully mate the 40-pin board-to-board type connector J5 on the Display/DSP Board to J1 on the Keypad Board inside the Front Cover Assembly.
9. Connect the control knob flex strip to connector J4 on the Display/DSP Board. The flex strip's stiffener surface should be towards the boards (directly adjacent to the connector latch) upon insertion into the connector. Lock the connector latch by pressing it fully against the connector housing.
10. Remote-Control Control Head Only: As shown in Figure 5-2, mate the three (3) front-to-rear flex strips to their respective connectors on the Display/DSP Board.



Do not pull on or twist the flex strips and follow the information in the previous section. If new flex strips are being used, add two (2) anti-chafe pads in the approximate locations as illustrated in Figure 5-2.

11. Local-Control Control Head Only: Connect the shortest 16-conductor flex strip between J9 on the Display/DSP Board and the respective connector of the PK Board in the front cavity of the radio. Do not pull on or twist the flex strips and follow the information in the previous **NOTE**.
12. Local-Control Control Head Only: Route the flex strip connected to the Display/DSP Board through the slot near the center of the Rear Housing Assembly.

13. Verify the perimeter gasket at the front of the Rear Housing Assembly is still in place. Re-seat it as necessary.
14. Local-Control Control Head Only: Mate the control head to the radio in accordance with the procedure presented in Section 5.4.2.2 on page 38.
15. Remote-Control Control Head Only: At the rear of the Rear Housing Assembly, verify all four captive screws each have a thrust washer. If not, obtain replacement washer(s), and remove and reinstall each captive screw with a washer.
16. Remote-Control Control Head Only: Assemble the Front Cover Assembly to the Rear Housing Assembly. Using a torque screwdriver with a T10 bit/tip, tighten the four screws to 6.0 inch-pounds (± 0.5 inch-pound).

5.4.5 Keypad Board Removal

A metallic-coated plastic shield and related hardware secure the Keypad Board to the front panel of the Front Cover Assembly. The following removal procedure is recommended:

1. Separate the Front Cover Assembly from the Rear Housing Assembly, if not already separated.
2. Remove the Display/DSP Board in accordance with the procedure presented in Section 5.4.3 on page 39.
3. Using a 5-millimeter nut driver, remove the two (2) standoffs on the side *opposite* of the internal controls and the respective flex strip. See Figure 5-3.
4. Remove the five (5) small Phillips-head screws securing the shield and board to the front panel. This shield covers the entire rear of the Keypad Board. On revision D (and later) control heads, as shown in Figure 5-3, one screw located near the system/group/channel selection control also secures a grounding spring.
5. Extract the board from the front panel by, from the front, gently pressing the microphone connector into the front panel, and then lifting the board from the rear of the front panel.
6. If keypads must also be removed, continue with the procedure presented in Section 5.4.6.

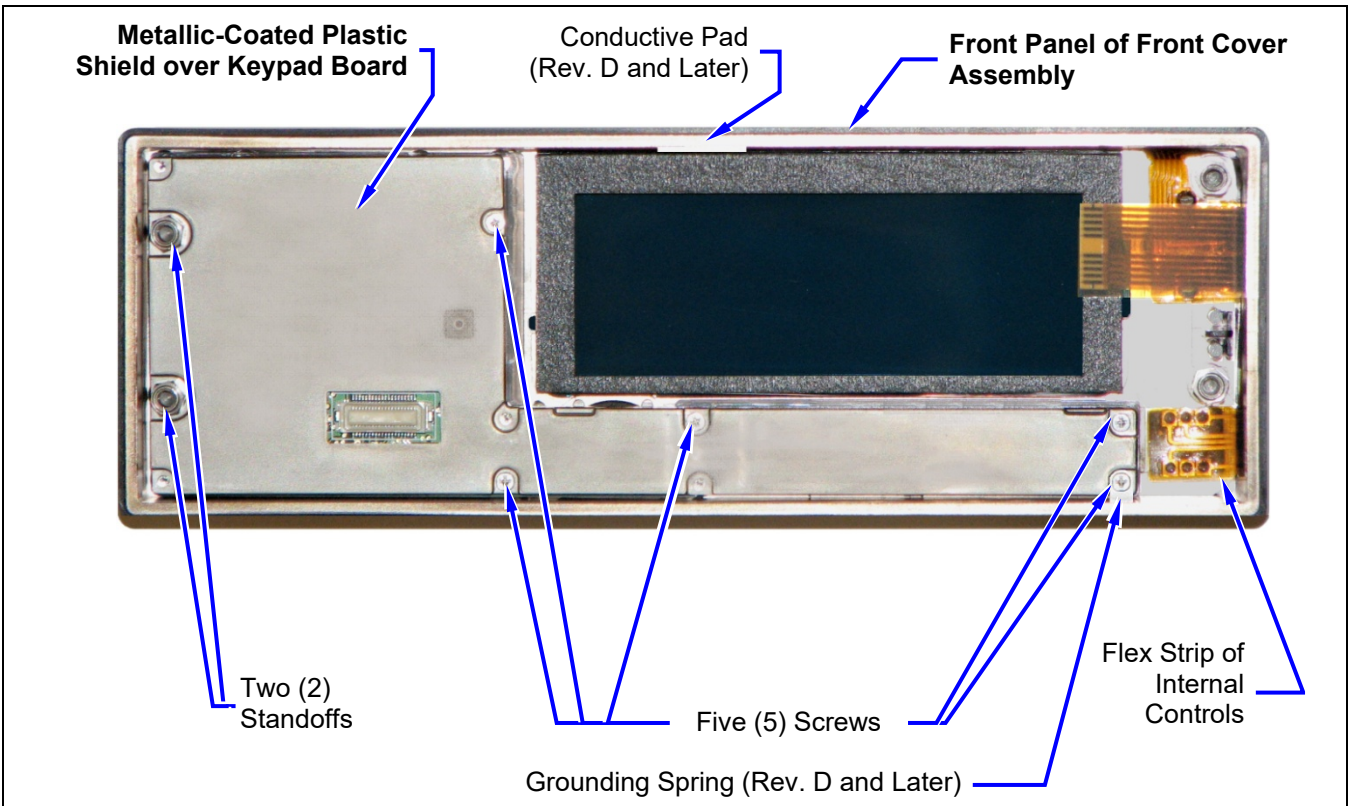


Figure 5-3: Keypad Board Shield and Related Hardware (Rear View of Front Panel)

5.4.6 Keypad, Keycap, and Ramp Control Removal

Each Front Cover Assembly has two (2) keypads. The larger keypad is for the control head's right-most buttons (as viewing from front of control head) and the +/- ramp control. The smaller keypad is for the A – C preset buttons and the ●/●● ramp control is located just below the display. The following removal procedure is recommended:

1. Remove the Keypad Board in the Front Cover Assembly, if not already removed. Use the procedure presented in Section 5.4.5.
2. From the front of the front panel, make a note of all keycap positions. Taking a picture may be helpful. Normal positions are shown in Figure 3-1 on page 12 for the Scan model control head and in Figure 3-2 (on page 12) for the System model control head.
3. To remove the larger keypad:
 - a. Remove the 12 Phillips-head screws securing its keypad lightguide to the front panel. See Figure 5-4.
 - b. Carefully lift the lightguide up and out of the front panel.
4. To remove the smaller keypad:
 - a. Remove the seven (7) Phillips-head screws securing its keypad lightguide to the front panel. See Figure 5-4.
 - b. Carefully lift the lightguide up and out of the front panel.
5. Remove any keycaps that remained in the front panel cavities.
6. Remove the ramp control(s) from the front panel, if necessary.

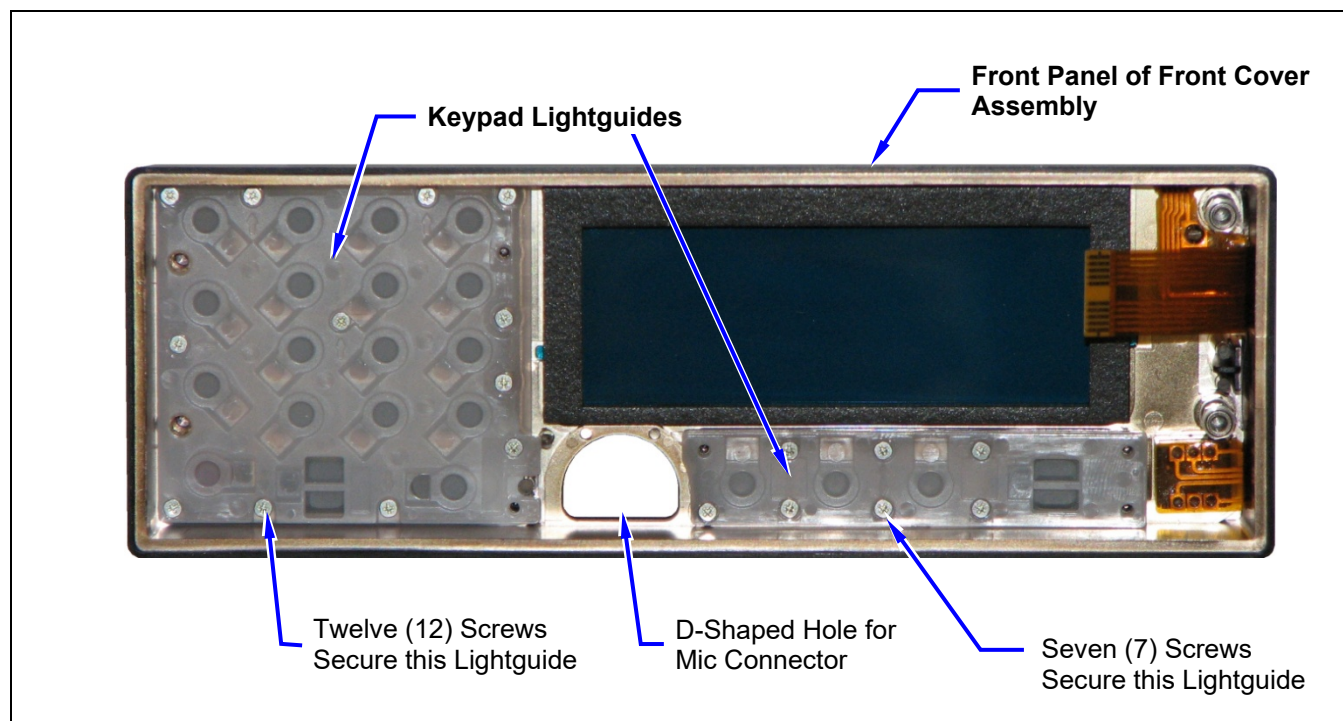


Figure 5-4: Keypad Lightguides and Related Hardware (Rear View of Front Panel)

5.4.7 Keypad, Keycap, and Ramp Control Installation

1. Inspect the interior of the front panel for any foreign material such as loose screws, etc. Clean as necessary.
2. If installing the *larger* keypad, install the ramp control *with the widest base* in the respective interior cavity near the inside-bottom of the front panel. This is the **+/-** ramp control. The ramp control's extended pin on its base must point towards the round cavity for the emergency button.

If installing the *smaller* keypad, install the ramp control *with the narrowest base* in the respective interior cavity near the inside-bottom of the front panel, and under the display. This is the **•/••** ramp control. The ramp control's extended pin on its base must point towards the three (3) oval-shaped holes for the preset buttons.

3. Install the keypad(s) into the respective recessed location(s) of the front panel. Using a finger or a dull non-abrasive tool, stroke the back side of each pad until it is firmly seated into the recessed location. Keypads can be installed with keycaps still attached.
4. Install the keypad lightguide(s) into the front panel.

Each lightguide has small counter-sunk holes, and molded-in arrows on one side that indicate which holes require screws. This side of the lightguide must be rear facing when the lightguide is seated in the cover. See Figure 5-4.

5. At the small counter-sunk holes, install but do not tighten short Phillips-head screws to secure each lightguide to the front panel. These screws are approximately ¼-inch long (6 millimeters). Do **not** use any of the longer screws for securing the Keypad Board and its shield to the front panel. The larger lightguide requires 12 screws and the smaller lightguide requires seven (7) screws. Some of these holes are identified by molded-in arrows. See Figure 5-4.

6. Tighten all screws. Start with the center-most screws first, working to the outer edges of the lightguide. Do **not** over-tighten, which may significantly warp the lightguide or damage the front panel. Torque should not exceed 1.4 inch-pounds. Slight warping at this point in the reassembly process is acceptable.
7. Verify all screw heads are below the rear-most surface of the lightguide.
Use a short straight edge such as the end of a small ruler if necessary.
8. At the front of the front panel, verify the two (2) ramp controls move freely up and down, and each automatically returns to the center position when released. If not, they may be reversed from one cavity to another, or in the correct cavities but upside down. Correct as necessary.

5.4.8 Keypad Board Installation

1. Place the front panel on a flat ESD-safe surface, in a rear-facing position.
2. Verify all 19 screws used to secure the keypad lightguide are in place and securely tight. As shown in Figure 5-4.
3. On the front of the Keypad Board, verify the microphone connector has the D-shaped rubber gasket surrounding it. If not, obtain a new gasket and slip it around the connector. The widest portion of the gasket must be nearest to the board.
4. Install the board into the rear of the front panel, slipping the mic connector through its D-shaped hole.
5. Place the shield over the board and loosely install five (5) Phillips-head screws.
Required screws are approximately ½-inch long (12 millimeters). As illustrated in Figure 5-3, two screws are required on each side of the mic connector, two are required next to the flex strip, and one is required just to the left of the display (as viewing from the rear of the front panel).
On revision D (and later) control heads, as shown in Figure 5-3, one screw located near the system/group/channel selection control also secures a grounding spring.
6. Loosely install the two (2) standoffs in the larger holes at the left side of the shield.
7. Tighten the five Phillips-head screws. Torque should not exceed 1.6 inch-pounds.
8. Tighten the two standoffs. Torque should not exceed 4.4 inch-pounds.
9. Verify each button at the front panel has a snap-action when pressed **and** when released.
10. Verify both ramp controls have a snap-action when pressed up and down. Each button must automatically return to its center position.
11. Install the Display/DSP Board and mate the Front Cover Assembly to the Rear Housing Assembly in accordance with the procedure presented in Section 5.4.4 on page 41.

5.4.9 Remote Interface Board Removal

Follow this procedure to remove the Remote Interface Board from the Rear Housing Assembly:

1. Separate the Front Cover Assembly from the Rear Housing Assembly if not already separated. Use the procedure presented in Section 5.4.3 on page 39. However, instead of disconnecting the three (3) flex strips at the Display/DSP Board, disconnect them at the Remote Interface Board.
2. Place the Front Cover Assembly (with the Display/DSP Board) aside in an ESD-safe location. Use caution as to not damage the Display/DSP Board and the flex strip connecting the board to the controls in the front of the assembly.
3. Using a small flat-blade screwdriver, remove the stainless-steel spring-clip securing the audio amplifier IC (U3) to the interior casting of the Rear Housing Assembly.
4. Using a 5-millimeter nut driver, remove the four (4) stainless-steel screw-locks at the DB-9 and DB-25 connectors on the rear of the assembly.
5. Using a 5/8-inch (or 16 mm) nut driver or wrench, remove the three (3) plastic hex nuts on the rear of the assembly that secure the CAN and speaker audio connectors.
6. Using a 1-inch (or 26 mm) nut driver or wrench, remove the large plastic hex nut on the rear of the assembly that secures the DC input power connector.
7. On the rear of the assembly, carefully press the connectors inside the assembly, so the Remote Interface Board moves towards the front of the assembly/casting.
8. Completely extract the board from the assembly/casting. If necessary, use two (2) small blunt-tipped objects (such as the eraser ends of two pencils) to push the board out of the casting via the connector holes in the rear of the casting.

5.4.10 Remote Interface Board Installation

Follow this procedure to install the Remote Interface Board into the Rear Housing Assembly:

1. Install three (3) board-edge grounding clips at the unmask areas on the edges of the Remote Interface Board, if not already installed. The wide tab of each clip should face towards the same side of the board as the audio amplifier IC (U3).



NOTE

Remote Interface Board revision D (and later) use the longer clips. Remote Interface Board revision C (and earlier) use the shorter clips.

2. Verify each circular connector on the rear of the board has a rubber washer (4 washers in total). If not, install one washer on each connector.
3. Verify the interior of the Rear Housing Assembly's casting is clean and free of any foreign material. Clean as necessary.
4. For the Remote Interface Board revision D (and later), use a small brush and apply a thin film (approximately 0.1 millimeters thick) of thermal heat-transfer compound to the rear surface of the audio amplifier IC (U3). Recommended compound types are listed in Section 5.4.1.
5. Install the Remote Interface Board into the casting of the Rear Housing Assembly. The rubber washers must remain on the circular connectors, hold the board so the external ends of these connectors are facing straight up, and then gently slide the Rear Housing Assembly down onto the board. Use gentle and evenly-distributed force to work the connectors through the holes in the rear of the casting. Do **not** bend the board!

6. Secure the audio amplifier IC (U3) to the casting by installing the stainless-steel clip. Center the clip in the small cavity protruding from the interior wall of the casting. Press the clip so it is flush with the edge of the audio amplifier IC.
7. At the rear of the assembly, install the four (4) stainless-steel screw-locks at the DB-9 and DB-25 connectors. Torque the screw-locks to approximately 5 inch-pounds.
8. At the rear of the assembly, install the four (4) plastic hex nuts on the board's circular connectors. The rounded surface of each nut should face outwards, so the nut's flattest surface will touch the rear surface of the casting. Do not tighten the nuts at this time.
9. Torque the four (4) plastic hex nuts to approximately 9 inch-pounds.
10. Verify the clip securing the audio amplifier IC (U3) to the casting is still pressed down flush with the edge of the IC. Also verify it is still centered within the small cavity.
11. Mate the Rear Housing Assembly to the Front Cover Assembly. Use the procedure presented in Section 5.4.4 (page 41).

5.4.11 Keycap Removal and Installation

Keycaps can be easily removed and installed without disassembling the control head.

To remove a keycap:

1. From the front of the front panel, insert the appropriate steel fingers of the Keycap Removal Tool into the top and bottom of the respective keycap's hole. Using the Keycap Removal Tool (part number TL-012188) is recommended. Refer to Section 8.1 (page 57) for ordering information.
2. Extract the keycap by pulling the tool back out away from the faceplate.

Alternately, a keycap can be removed using a small flat-blade screwdriver. Slip the tip of the screwdriver just above the keycap and gently push down to release its upper locking tab and snap it out of the hole.



CAUTION

If using a screwdriver to remove a keycap, use caution to avoid damaging the rubber keypad beneath the keycap.

To install a keycap:

1. Position the keycap in front of the correct front panel hole while observing correct orientation.
2. Using two fingers, slightly squeeze the locking tabs located on the top and bottom of the keycap, and then press the keycap into the hole.
3. Verify the keycap and keypad button combination has a snap-action when pressed and when released.

5.5 SOFTWARE RELEASE NOTES

Software release notes for the CH-721 control head are contained in publication number MS-013563-001. Information in MS-013563-001 includes, but is not limited to:

- New features supported with the latest software.
- Features not supported.
- Software/firmware upgrade procedures.
- Problem resolutions.

6 TROUBLESHOOTING

6.1 GENERAL

This section includes General Troubleshooting information (Table 6-1) which provides a list of symptoms, possible causes, and potential solutions. Table 6-2 provides a list of possible radio error codes. Supporting diagrams (schematics, component layout diagrams, etc.) are available in the back of this manual.

Table 6-1: General Troubleshooting

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Radio will not turn on.	No power.	Test the connection to the vehicle power supply.
Radio will not turn off.	If in multiple control head configuration, one of the attached control heads is still powered up.	Power off all control heads.
At power-up, an error message is displayed.	Radio may be programmed incorrectly.	See the Error Message Tables on the following pages for type of error and for a probable solution. Attempt to reprogram the personality, Flash and DSP using RPM.
No audio.	Speaker volume is muted.	Increase the volume level.
Poor audio.	Transmitting or receiving in a poor coverage area or subject to interference.	Check network connectivity and move to a better coverage area if possible. Report the area without coverage to an authorized network technician.
Radio will not transmit.	Radio may be out of coverage area or may be overheated.	Return to coverage area if possible. If overheated, let radio cool before retrying transmission. Report this failure to an authorized technician.
Control head randomly changes display.	In multiple control head configurations, another user may be operating the radio from another control head.	None
Encrypted calls cannot be made.	Not authorized to use.	Contact system administrator to request encryption privileges.
Transmitter inoperative or low power.	Radio may be programmed incorrectly or antenna may be damaged.	Defective antenna or antenna cabling - replace antenna or antenna cable. Programmed incorrectly - check personality.

6.2 STATUS AND ERROR CODES DISPLAYED AT CONTROL HEAD

The following table lists and defines error codes for EDACS, conventional, and P25 modes. Fatal errors typically cause the radio to automatically reset after a short delay. For non-fatal errors, the radio will typically resume operation after a short delay.

Table 6-2: Error Codes

DISPLAYED CODE	MEANING
FATAL SYSTEM ERROR CODES:	
Startup Errors	
(0x0004)	Flash memory checksum test error
(0x0005)	Flash memory part is unknown
(0x0006)	FIPS random IV test error
(0x0007)	FIPS bypass test error
(0x0008)	FIPS no voice keys error
(0x0009)	Flash memory write error
Initialization Error Codes	
(0x0022)	I2C driver initialization error
(0x0023)	I2C driver mode change error
(0x0024)	I2C driver write error
(0x0025)	UART driver failed initialization
(0x0026)	Timer initialization failed
(0x0027)	The microwire driver failed
DSP Driver Fatal Error Codes	
(0x0030)	DSP encryption module failed to load
(0x0031)	DSP encryption module failed to unload
(0x0032)	DSP encryption module load/unload errors reported
(0x0033)	DSP encryption module failed to receive a response to load command
(0x0034)	DSP encryption module failed to receive a response to unload command
(0x0035)	DSP encryption module response contains invalid module ID
(0x0039)	FIPS DES self-test failed to provide correct answer
LCD Driver Fatal Error Codes	
(0x0040)	LCD did not acknowledge message
(0x0041)	LCD hardware is invalid
CAN Driver Fatal Error Codes	
(0x0060)	CAN server semaphore initialization failure
IPC DSP Driver Fatal Error Codes	
(0x0070)	DSP did not read a message within 500 milliseconds
(0x0071)	DSP gave a response longer than buffer
(0x0072)	DSP did not read stream data within 500 milliseconds
(0x0073)	ARM tried to write more data than DSP could store

DISPLAYED CODE	MEANING
(0x0074)	ARM tried to write DSP code and failed
(0x0075)	ARM did not get an acknowledgement of a command to the DSP
(0x0076)	The buffer between the ISR and the IPC task overflowed
(0x0077)	Data was lost between the ISR and the IPC task
(0x0078)	The ARM ISR buffer could not hold this D-Channel message
(0x0079)	Data was lost between the ISR and the IPC D-Channel task
(0x007A)	The DSP tried to write zero length D-Channel data message
(0x007B)	The ARM missed a C/R Channel DSP message
(0x007c)	The ARM missed a D-Channel DSP message
Radio Driver Fatal Error Codes	
(0x0080)	Transceiver failed to program synthesizer due to data collision(s)
(0x0081)	Transceiver failed to program the MCU after N retries
(0x0082)	Transceiver failed to find proper calibration data
(0x0083)	The XCVR MCU failed to program the rx adc after N retries
(0x0084)	The XCVR Excalibur Rx ADC calibration failed to complete
(0x0085)	The XCVR failed to reset the MCU after N retries
(0x0086)	The SPI sequence aborted and the XCVR failed to configure the RF hardware.
(0x0087)	XCVR is in an unknown state
(0x0088)	The RFLSI message retried out
(0x0089)	The RFLSI did not come out of the discovery phase
(0x008a)	The RFLSI missed a bunch of heartbeats
(0x008b)	AFE did not tune correctly
MCBSP Fatal Error Codes	
(0x0093)	McBSP configuration error
RF Parameter Driver Fatal Error Codes	
(0x00A0)	The RFPARAM CM Table not initialized
(0x00A1)	The RFPARAM Preselector Table not initialized
(0x00A2)	The RFPARAM TCXO Table not initialized
(0x00A3)	The RFPARAM RSSI Table not initialized
PA Parameter Driver Fatal Error Codes	
(0x00B0)	The PAPARAM CM Table not initialized
(0x00B1)	The PAPARAM TGC Table not initialized
(0x00B2)	The PAPARAM TX BIAS Table not initialized
Operating System Fatal Error Codes	
(0x0100)	Interrupt had no handler
(0x0101)	Pre-fetch abort handler
(0x0102)	Data abort handler
(0x0103)	Reserved interrupt handler

DISPLAYED CODE	MEANING
(0x0104)	Unexpected interrupt handler
(0x0105)	Interrupt handler failed to set-up the IRQ
(0x0106)	OS fork creation process failed
(0x0107)	OS pipe overflow failure
(0x0108)	OS task creation process failed
(0x0109)	Task stack overflowed
(0x0110)	OS timer task creation failed
(0x0111)	OS returned fatal error
(0x0112)	OS fork stack overflowed
(0x0113)	OS priority fork stack overflowed
(0x0114)	GPIO config was wrong - check radio config
(0x0115)	MPUIO config was wrong - check radio config
(0x0116)	Could not set radio type right using sector 0
(0x0117)	Failure in download system
(0x0118)	Memory allocation failed
(0x0119)	Semaphore pending error
(0x0120)	Semaphore post operation error
(0x0121)	OS fork stack had nucleus error
(0x0122)	OS priority fork stack had nucleus error
(0x0123)	The data stack overflowed
(0x0124)	The protocol stack overflowed
(0x0125)	The RI stack overflowed
(0x0126)	The UI stack overflowed
(0x0127)	The watchdog stack overflowed
(0x0128)	The MAINT stack overflowed
(0x0129)	The HDT stack overflowed
(0x0130)	The CAN stack overflowed
(0x0131)	The IPC stack overflowed
(0x0132)	The MCU stack overflowed
(0x0133)	The startup stack overflowed
(0x0134)	The programmer/bootloader stack overflowed
(0x0135)	The Bluetooth stack overflowed
(0x0136)	The I/O stream handler died
(0x0137)	The string for the log store was too long
(0x0138)	A semaphore post operation went badly wrong
(0x0139)	The internet Low Bitrate Codec (iLBC) stack
FATAL APPLICATION ERROR CODES:	
Protocol Stack Codes	
(0x1210)	EDACS/EA stack main state was corrupted

DISPLAYED CODE	MEANING
(0x1211)	P25T stack main state was corrupted
(0x1212)	Conventional stack main state was corrupted
(0x1213)	Bluetooth stack received a bad message
Test unit fatal sys error codes	
0x1303	CISYS message buffer not enabled
Conventional Fatal System Error Codes	
(0x1400)	Error calling RADC function
(0x3401)	Synthesizer became unlocked
(0x1402)	UI message buffer not enabled
(0x1408)	Error calling RADC function in ECP1 scan
(0x1450)	Error calling RADC function in CONVTX - idle mode
(0x1451)	Invalid TX Block Type was set in P25C
(0x1452)	Error calling RADC function in trunked P25
(0x1453)	Error reading serial number
(0x1454)	Bad message type requested
(0x1455)	Bad registration type requested
(0x1456)	Bad registration type on returning with P25_REG_COMPLETE action
(0x1457)	Bad activation type requested
(0x1458)	Radio did not get a RAMPDOWN from the DSP through a bunch of retries
(0x1460)	Bad state called for the KMM Handler state machine
(0x1461)	Bad state within custom scan restore home
(0x1462)	Invalid data Rx queue index detected
(0x1463)	Invalid crypto state / action requested
Personality Interface Fatal System Error Codes	
(0x5500)	Personality data is not present
(0x5501)	Flash personality Cyclic Redundancy Check (CRC) did not match EEPROM's CRC
(0x5502)	Personality descriptor table CRC error
(0x5504)	Custom frequency set table error
(0x5505)	Personality store identifier is not present
(0x5508)	The variable personality write to flash conversion failed
(0x5509)	Increased Personality files are not present
(0x5510)	Enhanced Personality Write Failure
User Interface Fatal System Error Codes	
(0x5600)	Input/Output device error
(0x1601)	Out of memory
(0x1602)	Maximum number of timers exceeded
(0x1603)	Too many open windows
(0x1604)	Out of memory

DISPLAYED CODE	MEANING
(0x1605)	Invalid parameter
(0x1606)	RI BBOS message buffer full error
(0x1607)	RI System (EDACSBOS message buffer full error)
(0x1608)	CI BBOS message buffer full error
(0x5609)	I/O device type from personality not supported
(0x1614)	UI IBOS message buffer full error
(0x1615)	No more memory
(0x1616)	No more memory
(0x1617)	UI studio trash message received error
Test Unit Fatal System Error Codes	
(0x1706)	The test unit could not write serial data out
Enhanced Keyload Fatal System Error Codes	
(0x1804)	A general keyload error has occurred
FIPS 140 Fatal System Error Codes	
(0x1902)	Invalid DESMAC key
(0x1903)	DESMAC checksum failed
(0x1904)	DESMAC DSP attach failed
(0x1905)	BAD MSGID passed internally
(0x1A00)	Bad cal data type requested
NON-FATAL APPLICATION ERROR CODES:	
(0)	UNKNOWN " Calling error
(1)	FEAT DAT" Feature encryption error message
(2)	NO TRACK" Tracking data was bad
(3)	PERSNLTY" Personality recoverable error message
(4)	G-STAR " GSTAR Error
(5)	TONE ENC" Tone Encode Error
(6)	VOC CNFG" Vocoder configuration error
(7)	DSP ENCR" Flash DSP encryption module CRC Error
(8)	NC ERROR" Noise Cancellation Error
(9)	MDC Error
(10)	Wideband Error
(11)	TSBK RSP TSBK on Analog Error
(12)	DES configuration error
(13)	CAN Bus audio error when DSP underflows on Microphone samples
Flags for Error Handling and Display	
(0x8000)	If this bit is OR'd with the error number, the user must clear the error (no timeout)
(0x0FFF)	lag mask to extract error code from combined code/control bits
(2000)	Fixed error message display timeout in mS

DISPLAYED CODE	MEANING
Personality Conversion Error Codes	
(0x0100)	EE Prom read error
(0x0101)	EE Prom write error
(0x0102)	Invalid Argument to Function
(0x0103)	Invalid variable personality checksum
(0x0104)	Invalid variable personality length
(0x0105)	Variable personality section not found
(0x0106)	Variable personality conversion failure
(0x0107)	Constant personality conversion failure
(0x0108)	Descriptor table CRC failure
(0x0109)	Descriptor table size failure
(0x0110)	The version of RPM used to program with is too old
(0x0150)	NULL Pointer was returned
Feature Encryption Errors	
(0x0550)	Cannot read EID
(0x0551)	Feature data string size does not match stored size
(0x0552)	Decryption failure
(0x0554)	System cannot run without PROSCAN feature enabled.
(0x0555)	WB channel cannot run with WB Disabled feature enabled.
(0x0556)	WB system cannot run with WB Disabled feature enabled.
(0x0557)	TSBK On Analog feature not enabled.
Calibration Parameter Error Codes	
(0x0560)	ECP calibration data missing; data updated to current defaults.
(0x0590)	TestApp Calibration data missing; Cal data updated.
System load/configuration error codes:	
(0x0862)	Attempt to use DES encryption with the DES feature turned off
(0x0863)	Attempt to use AES encryption with the AES feature turned off
(0x0864)	Attempt to use DES encryption with no module available
(0x0865)	Attempt to use AES encryption with no module available
(0x0866)	DES encryption module loaded but bad
(0x0867)	AES encryption module loaded but bad
(0x0868)	Attempt to use custom encryption with no module available
(0x0869)	AES encryption module loaded but was too old
(0x0873)	Error loading DES module
(0x0874)	Error loading AES module
(0x0875)	Error loading CUST module
(0x0876)	FIPS feature is enabled but a NON-FIPS module is loaded
(0x0877)	Personality is set for a different encryption type than system and mixed key is not allowed

DISPLAYED CODE	MEANING
(0x0878)	Attempt to use ARC4 encryption with the ENC_LITE feature turned off
(0x0880)	Group is set to digital but system vocoder is set to analog
(0x0881)	VG is not supported by the DSP
(0x0882)	Aegis is not supported by the DSP
(0x0883)	IMBE is not supported by DSP
(0x0891)	No G-STAR response from DSP
(0x0892)	No tone encode response from DSP
(0x0893)	No MDC response from DSP
(0x0896)	No TSBK on Analog response from DSP
(0x0897)	VRB not available
(0x0904)	Error reading from the PIR_CRYPT_KEY table
(0x0905)	Error reading one DES key from Digital Config table
(0x0906)	Error zeroizing ARC4 key store
(0x0907)	Error cannot load ARC4 keys because ENC_LITE feature is disabled
(0x0953)	DSP Underflow condition on a mobile radio leading to a possible Tx Drone Condition

7 TECHNICAL ASSISTANCE

The Technical Assistance Center's (TAC) resources are available to help with overall system operation, maintenance, upgrades, and product support. TAC is the point of contact when answers are needed to technical questions.

Product specialists, with detailed knowledge of product operation, maintenance, and repair provide technical support via a toll-free (in North America) telephone number. Support is also available through mail, fax, and e-mail.

For more information about technical assistance services, contact your sales representative, or contact the Technical Assistance Center directly at:

North America:	1-800-528-7711
International:	1-434-385-2400
Fax:	1-434-455-6712
E-mail:	PSPC_tac@l3harris.com

8 REPLACEMENT PARTS

8.1 GENERAL INFORMATION

Parts listed in Sections 8.2 and 8.3 can be ordered through the L3Harris Customer Care center. Section 8.2 lists parts that are grouped together in a kit along with other similar parts. Individual parts within a kit cannot be ordered separately. Refer to the L3Harris Service Parts and Accessories Catalog for additional information. To order replacement parts through the L3Harris Customer Care center, call, fax or email our ordering system:

Contact the Customer Care Center at <https://www.l3harris.com/all-capabilities/pspc-customer-care> or:

North America:

Phone Number:	1-800-368-3277
Fax Number:	1-321-409-4393
E-mail:	PSPC_CustomerFocus@l3harris.com

International:

Phone Number:	1-434-455-6403
Fax Number:	1-321-409-4394
E-mail:	PSPC_InternationalCustomerFocus@l3harris.com

8.2 KITTED PARTS

Kitted parts available for the CH-721 Scan and System model control heads are listed in Table 8-1. Complete control heads, and installation-related items such as mounting brackets and microphones are **not** listed.

Table 8-1: Kitted Parts Available for CH-721 Scan and System Model Control Heads

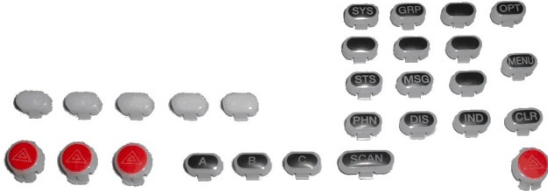
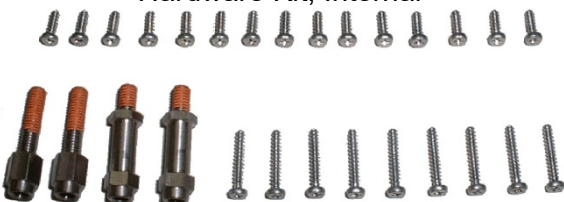
KIT NAME AND ILLUSTRATION	SERVICE PARTS KIT PART NUMBER	KIT INCLUDES (Items Listed in Parts List Beginning On:)
Knob Kit, Complete (Inner and Outer) 	MA-013324	Page 70 Items 7, 8, 12, & 13 (Items 7 & 8 include set screws)
Knob Kit, Outer (Less Cores & Set Screws) 	FM-013326	Page 70 Items 12 & 13
Volume Knob Assembly, Complete 	MA-017696-001	Page 70 Item 13
Channel Knob, Complete 	MA-017696-002	Page 70 Item 12
Keycap Kit, Scan 	FM-013332	Page 70 Items 22, 23, 24, 25, 26, 27, 28, & 29. Also includes (3) large blank keycaps, (5) small blank keycaps, and (3) emergency keycaps.
Keycap Kit, System 	FM-013327	Page 70 Items 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, & 37. Also includes (3) large blank keycaps, (3) small blank keycaps, and (3) emergency keycaps.
Hardware Kit, Internal 	FM-013329	Page 70 Items 15, 16, 17, & 18

Table 8-1: Kitted Parts Available for CH-721 Scan and System Model Control Heads

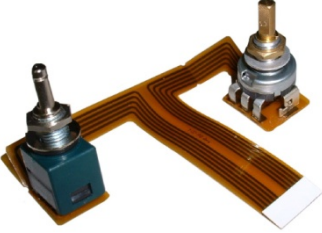
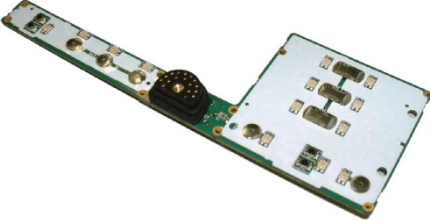
KIT NAME AND ILLUSTRATION	SERVICE PARTS KIT PART NUMBER	KIT INCLUDES (Items Listed in Parts List Beginning On:)
Switch Module Kit 	SW-013309	Page 70 Items 19, & 21 (Item 21 includes flex strip, mounting nuts and flat washers)
Front Housing Sub-Assembly, Scan (Less Boards) 	MA-013348	Page 70 Items 1 (Scan), 2, 3, 4 (Scan), 5, 9, 10 (Scan), 11, 15, 18, 22, 23, 24, 25, 26, 27, 28, & 29
Front Housing Sub-Assembly, System (Less Boards) 	MA-013317	Page 70 Items 1 (System), 2, 3, 4 (System), 5, 9, 10 (System), 11, 18, 15, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, & 37
Keypad Board Kit, Scan (Includes Board and Mic Connector Gasket) 	FM-013347	Page 70 Items 14 & 20 (Scan)

Table 8-1: Kitted Parts Available for CH-721 Scan and System Model Control Heads

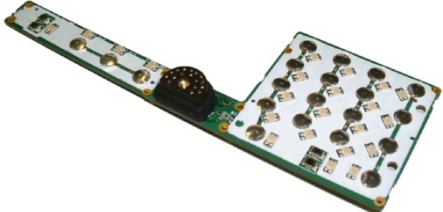
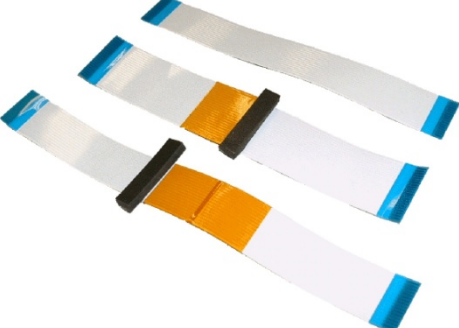
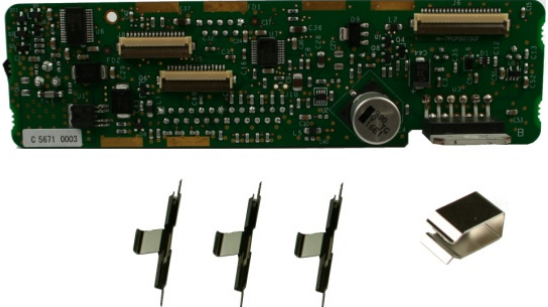
KIT NAME AND ILLUSTRATION	SERVICE PARTS KIT PART NUMBER	KIT INCLUDES (Items Listed in Parts List Beginning On:)
Keypad Board Kit, System (Includes Board and Mic Connector Gasket) 	CB-013319	Page 70 Items 14 & 20 (System)
Keypad Kit, Scan 	MA-013346	Page 70 Items 2, 3, 4 (Scan), 5, 10 (Scan), 11, & 15
Keypad Kit, System 	FM-013330	Page 70 Items 2, 3, 4 (System), 5, 10 (System), 11, & 15
Flex Strip Kit, Remote-Control 	FM-013350	Page 66 Items 4, 5 & 6 <u>or</u> Page 68, Items 4, 5 & 6
Remote Interface Board Kit 	MA-013352 (Rev. G)	Page 73 Items 3 & 4. Also includes (3) board-edge grounding clips and plastic connector hex nuts.

Table 8-1: Kitted Parts Available for CH-721 Scan and System Model Control Heads

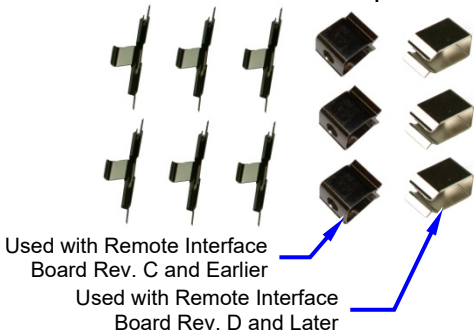
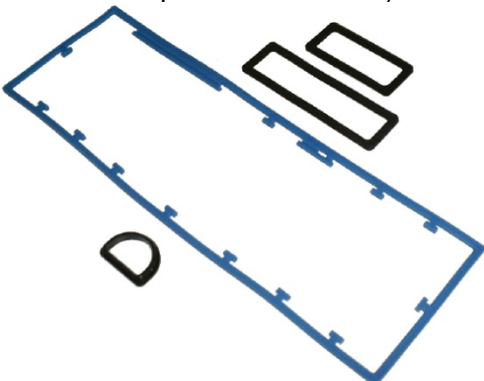
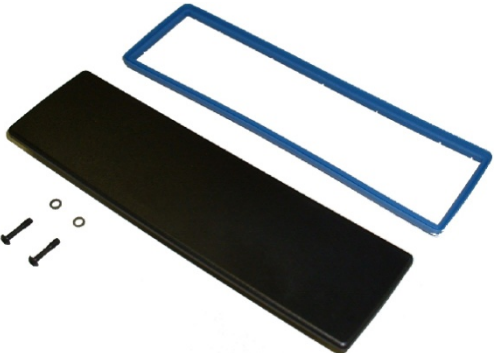
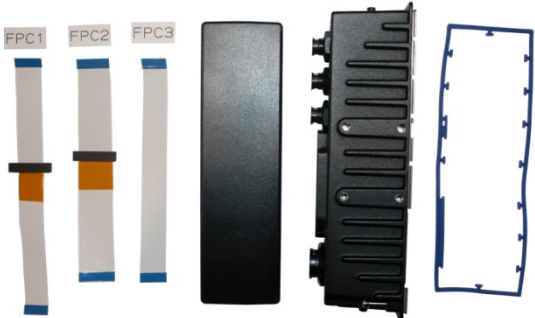
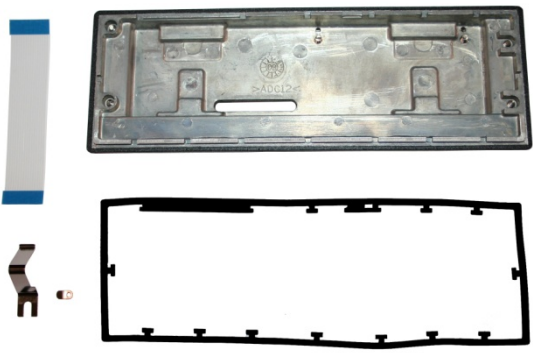
KIT NAME AND ILLUSTRATION	SERVICE PARTS KIT PART NUMBER	KIT INCLUDES (Items Listed in Parts List Beginning On:)
Remote Mount Clip Kit  Used with Remote Interface Board Rev. C and Earlier Used with Remote Interface Board Rev. D and Later	MA-013358 (Rev. B)	Page 73 Items 3 & 4 and board-edge grounding clips.
Gasket Kit, Remote & Mic (for CH-721 Rear Housing Assembly and Microphone Connector) 	FM-013353	Page 70 Item 14 and Page 73 Items 2, 6, & 7
Hardware Kit, Internal 	FM-013329	Page 70 Items 15, 16, 17, & 18
Hardware Kit, Local-Control Rear Housing (Exterior Hardware) 	MA-013359	Page 72 Items 3, 4, & 5

Table 8-1: Kitted Parts Available for CH-721 Scan and System Model Control Heads

KIT NAME AND ILLUSTRATION	SERVICE PARTS KIT PART NUMBER	KIT INCLUDES (Items Listed in Parts List Beginning On:)
Hardware Kit, Remote-Control Rear Housing (Exterior Hardware) 	MA-013360	Page 73 Items 8, 9, & 10
Front Cover Kit for Remote-Mount Radios 	MA-013357	(See the maintenance manual for the respective radio.)
Front-Mount to Remote-Mount Conversion Kit 	KT-014494-001	(See Section 8.1 on page 57 for additional information.)
	KT-014494-002	Page 72 Items 1, 2, 4, & 5 and Page 67 Item 4

8.3 NON-KITTED PARTS

Non-kitted parts available for the CH-721 Scan and System model control heads are listed in Table 8-2. Complete control heads, and installation-related items such as mounting brackets and mics are not listed.

Table 8-2: Non-Kitted Parts Available for CH-721 Scan and System Model Control Heads

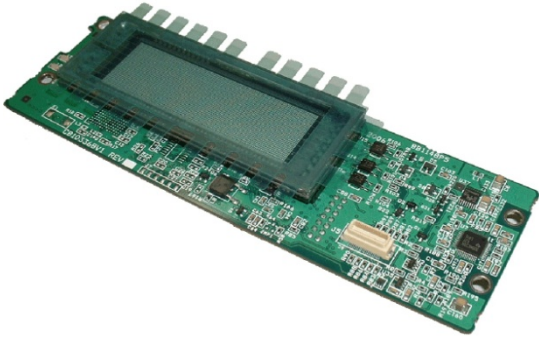
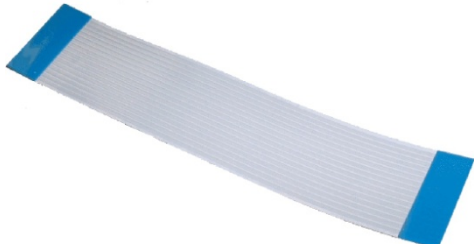
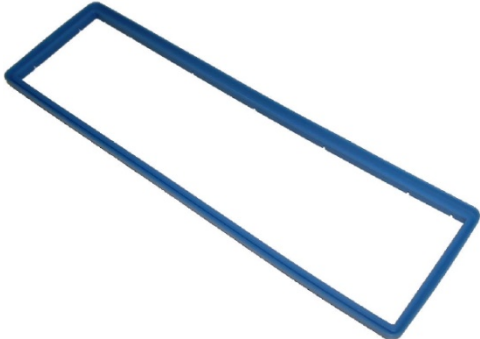
PART NAME AND ILLUSTRATION	SERVICE PARTS PART NUMBER	PART INCLUDES (Items Listed in Parts List Beginning On:)
Display/DSP Board (Includes Board and Display EMI Shield) 	FM-013351	Page 66 Item 2 (Scan) or Page 67 Item 2 (System) and Display EMI Shield
Keypad Shield 	FM-013325	Page 70 Item 6
Flex Strip, Local-Control 	FM-013349	Page 65 Item 4 (Scan) or Page 67 Item 4 (System)

Table 8-2: Non-Kitted Parts Available for CH-721 Scan and System Model Control Heads

PART NAME AND ILLUSTRATION	SERVICE PARTS PART NUMBER	PART INCLUDES (Items Listed in Parts List Beginning On:)
Gasket, Rear Seal Perimeter (for CH-721 with Local/Front-Mount Radio) 	FM-013354	(See the maintenance manual for the respective radio.)
DB-9 Serial Port Waterproof Cover 	FM-104859-001	(Not shown in this manual)
DB-25 Serial Port Waterproof Cover 	FM-104859-002	(Not shown in this manual)
Cover, Watertight, Mic Connector 	FM-017900-001	(Not shown in this manual)
CAN Terminator, Straight (2 pcs) 	CD-014027-001	(Not shown in this manual)

8.4 KEYCAP REMOVAL TOOL

Keycap Removal Tool TL-012188 can be used to quickly remove keycaps from the CH-721 Scan and System model control heads. Refer to the contact information in Section 8.1 on page 57 for ordering information. Section 5.4.11 on page 47 includes keycap removal and installation procedures.

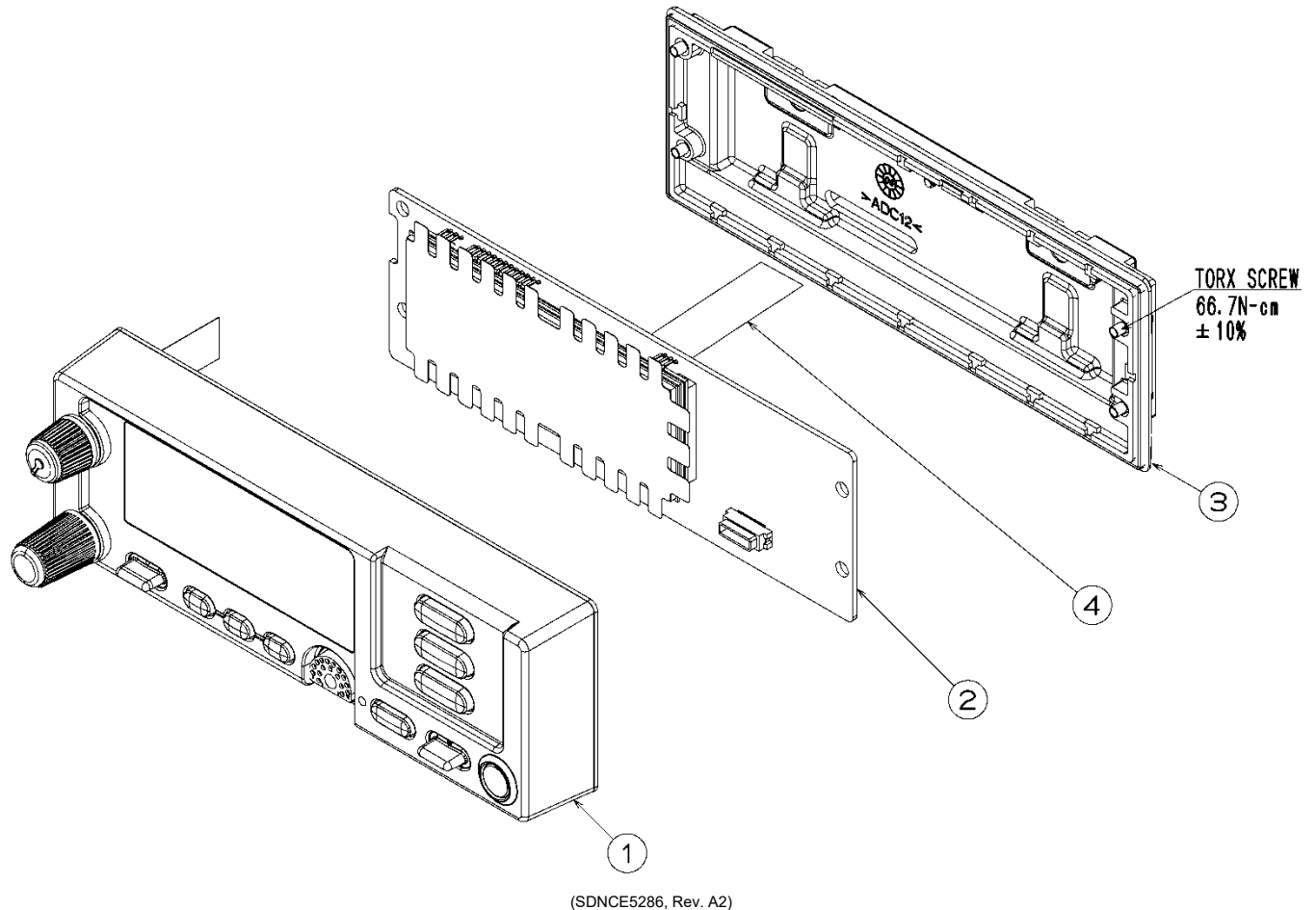


9 ASSEMBLY DIAGRAMS WITH PARTS LISTS

This section includes assembly diagrams and parts lists for the CH-721 control heads. In the mechanical assembly diagrams, circled numbers correspond to the item numbers in the respective parts list. Item numbers not listed in the respective parts list are not applicable and/or not used.

9.1 MECHANICAL ASSEMBLIES

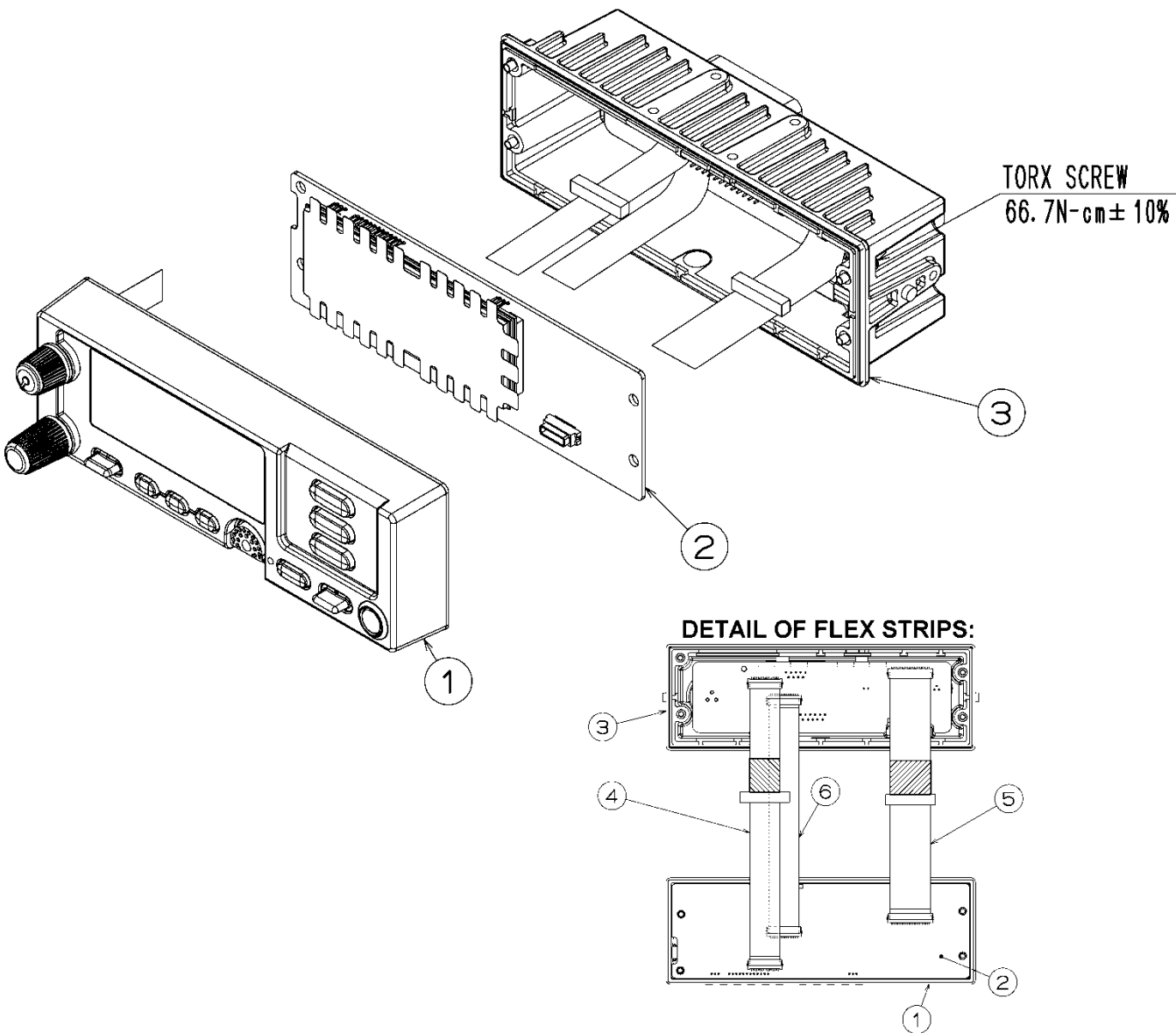
9.1.1 CH-721 Scan Model Control Head CU23218-0001 (for Local Control)



CH-721 SCAN MODEL CONTROL HEAD CU23218-0001

ITEM	DESCRIPTION
1	Assembly, Scan Front Cover. (See page 69 for exploded view assembly diagram.)
2	Assembly, Display/DSP Board. (See page 74 for component-level assembly diagram.)
3	Assembly, Local Rear Housing. (Includes captive screws, grounds clips and seal. See page 72 for exploded view assembly diagram.)
4	Flex Strip, FPC: 16-conductor, 5-inch.

9.1.2 CH-721 Scan Model Control Head CU23218-0002 (for Remote Control)

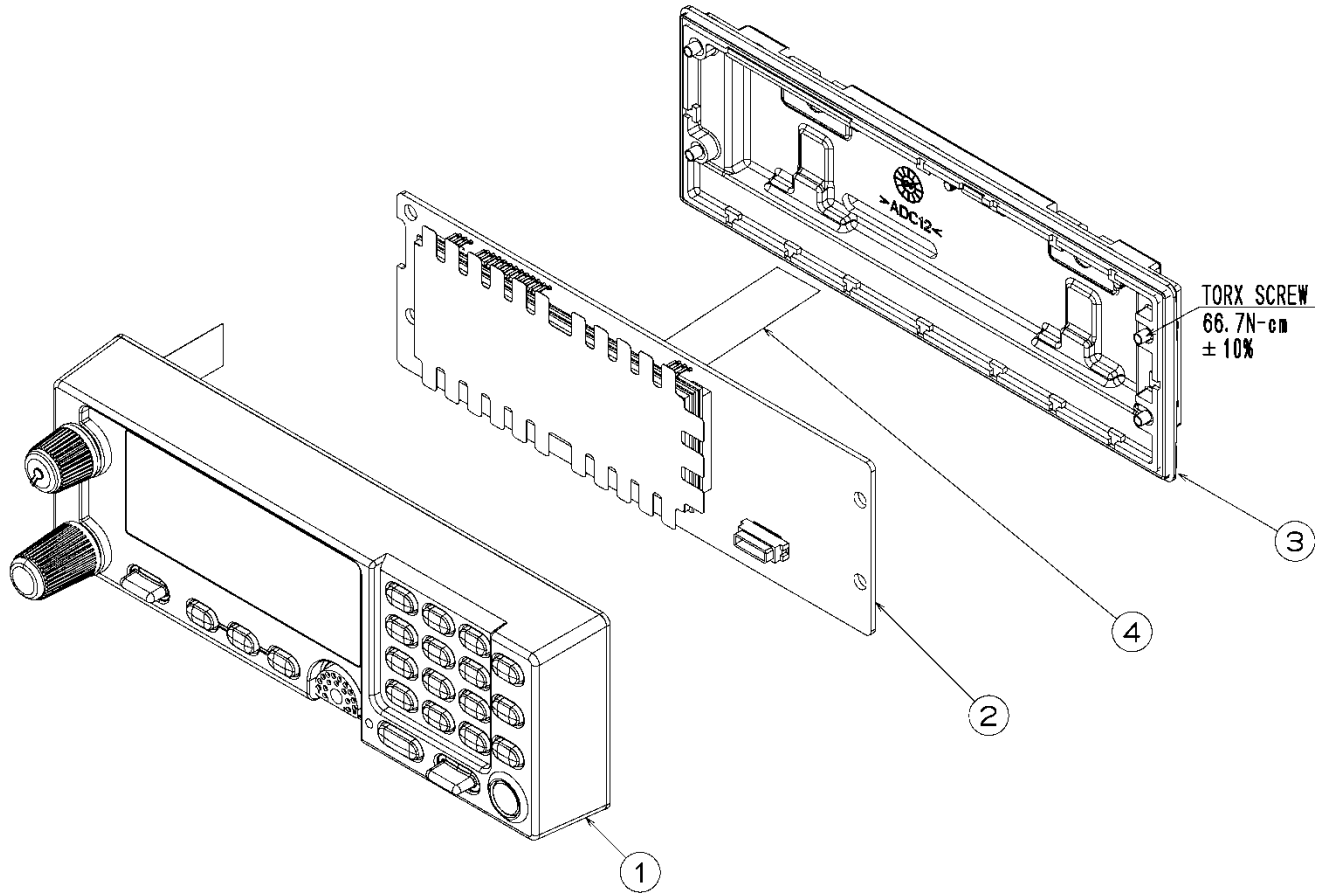


(SDNCE5284 Rev. A2)

CH-721 SCAN MODEL CONTROL HEAD CU23218-0002

ITEM	DESCRIPTION
1	Assembly, Scan Front Cover. (See page 69 for exploded view assembly diagram.)
2	Assembly, Display/DSP Board. (See page 74 for component-level assembly diagram.)
3	Assembly, Rear Housing. (See page 73 for exploded view assembly diagram.)
4	Flex Strip, FPC: 16-conductor, 6-inch, with Anti-chafe pad.
5	Flex Strip, FPC: 22-conductor, 4-inch, with Anti-chafe pad.
6	Flex Strip, FPC: 16-conductor, 5-inch.

9.1.3 CH-721 System Model Control Head CU23218-0003 (for Local Control)

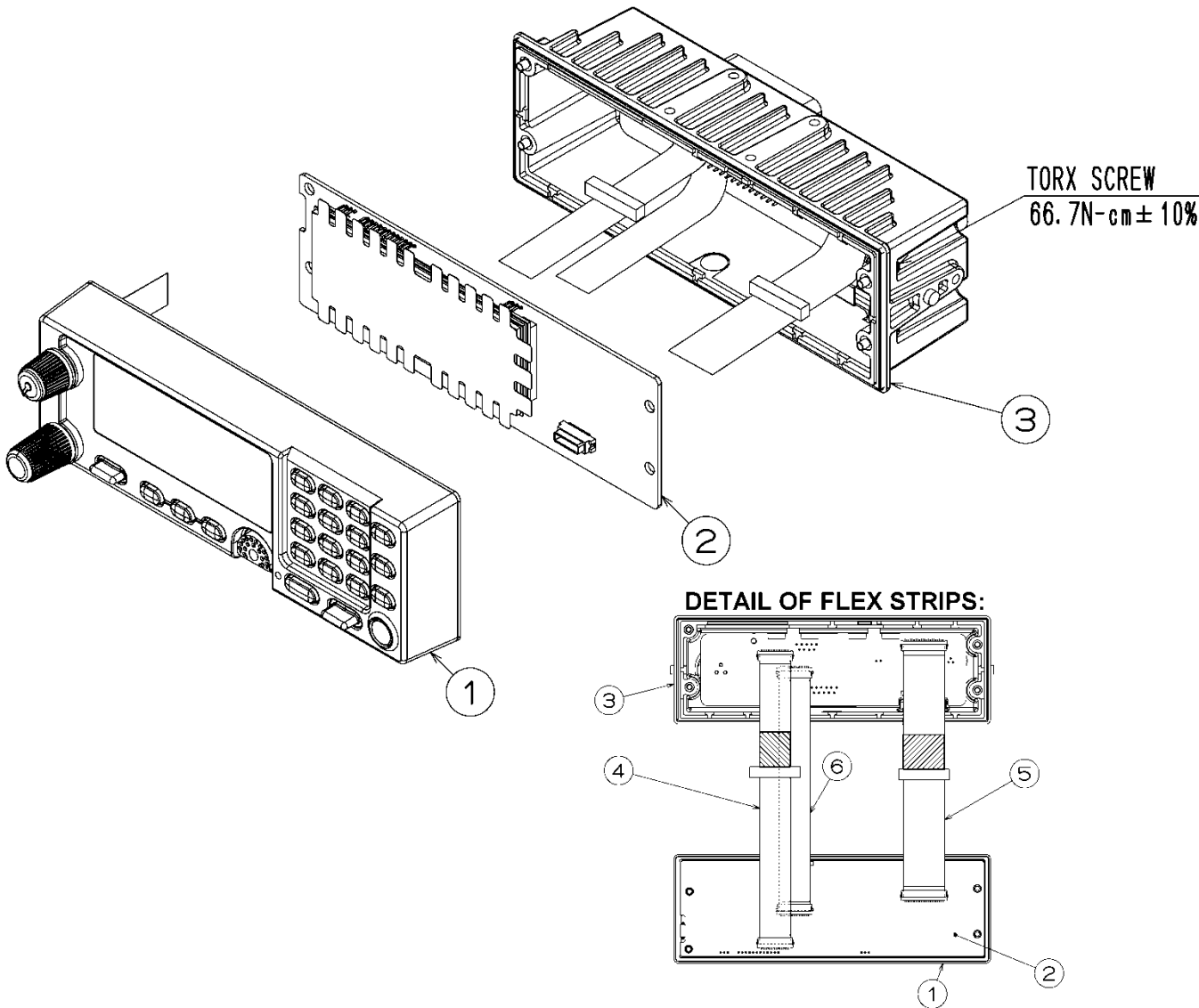


(SDNCE5285, Rev. A2)

CH-721 SYSTEM MODEL CONTROL HEAD CU23218-0003

ITEM	DESCRIPTION
1	Assembly, System Front Cover. (See page 70 for exploded view assembly diagram.)
2	Assembly, Display/DSP Board. (See page 74 for component-level assembly diagram.)
3	Assembly, Local Rear Housing. (Includes captive screws, grounds clips and seal. See page 72 for exploded view assembly diagram.)
4	Flex Strip, FPC: 16-conductor, 5-inch.

9.1.4 CH-721 System Model Control Head CU23218-0004 (for Remote Control)

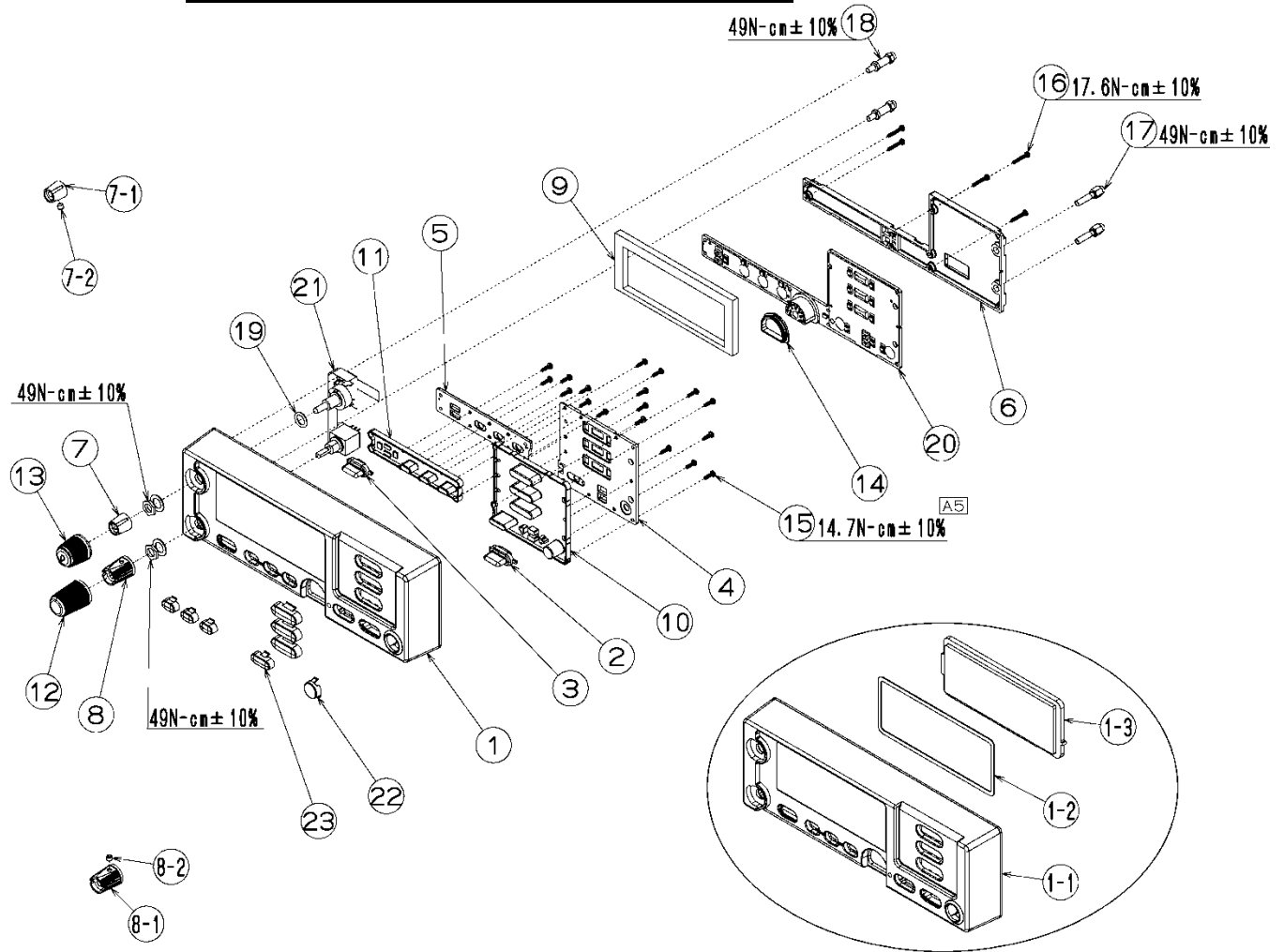


(SDNCE5283 Rev. A2)

CH-721 SYSTEM MODEL CONTROL HEAD CU23218-0004

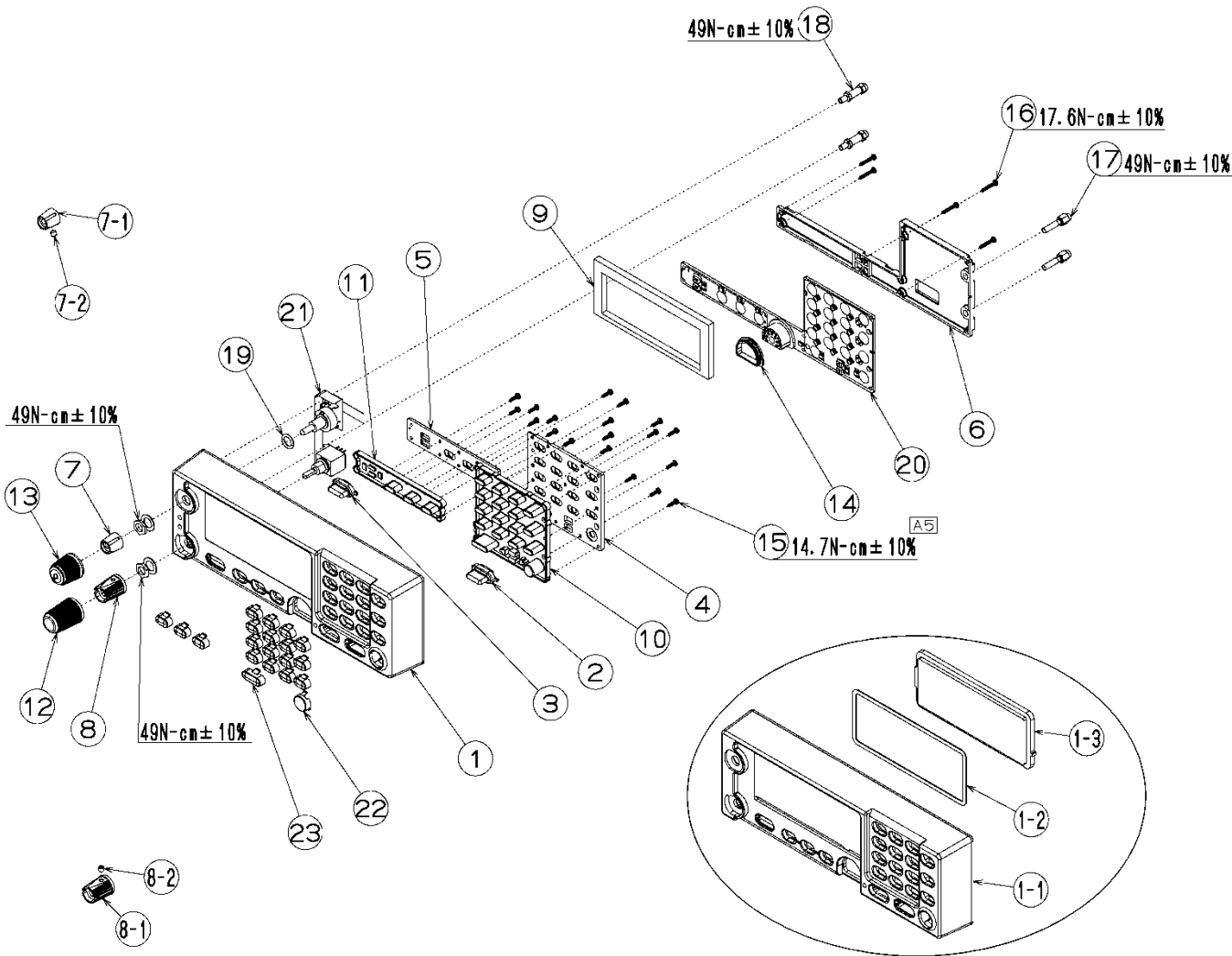
ITEM	DESCRIPTION
1	Assembly, System Front Cover. (See page 70 for exploded view assembly diagram.)
2	Assembly, Display/DSP Board. (See page 74 for component-level assembly diagram.)
3	Assembly, Rear Housing. (See page 73 for exploded view assembly diagram.)
4	Flex Strip, FPC: 16-conductor, 6-inch, with Anti-chafe pad.
5	Flex Strip, FPC: 22-conductor, 4-inch, with Anti-chafe pad.
6	Flex Strip, FPC: 16-conductor, 5-inch.

9.1.5 CH-721 Scan Model Front Cover Assembly



(SPBC05143 Rev. A5)

9.1.6 CH-721 System Model Front Cover Assembly



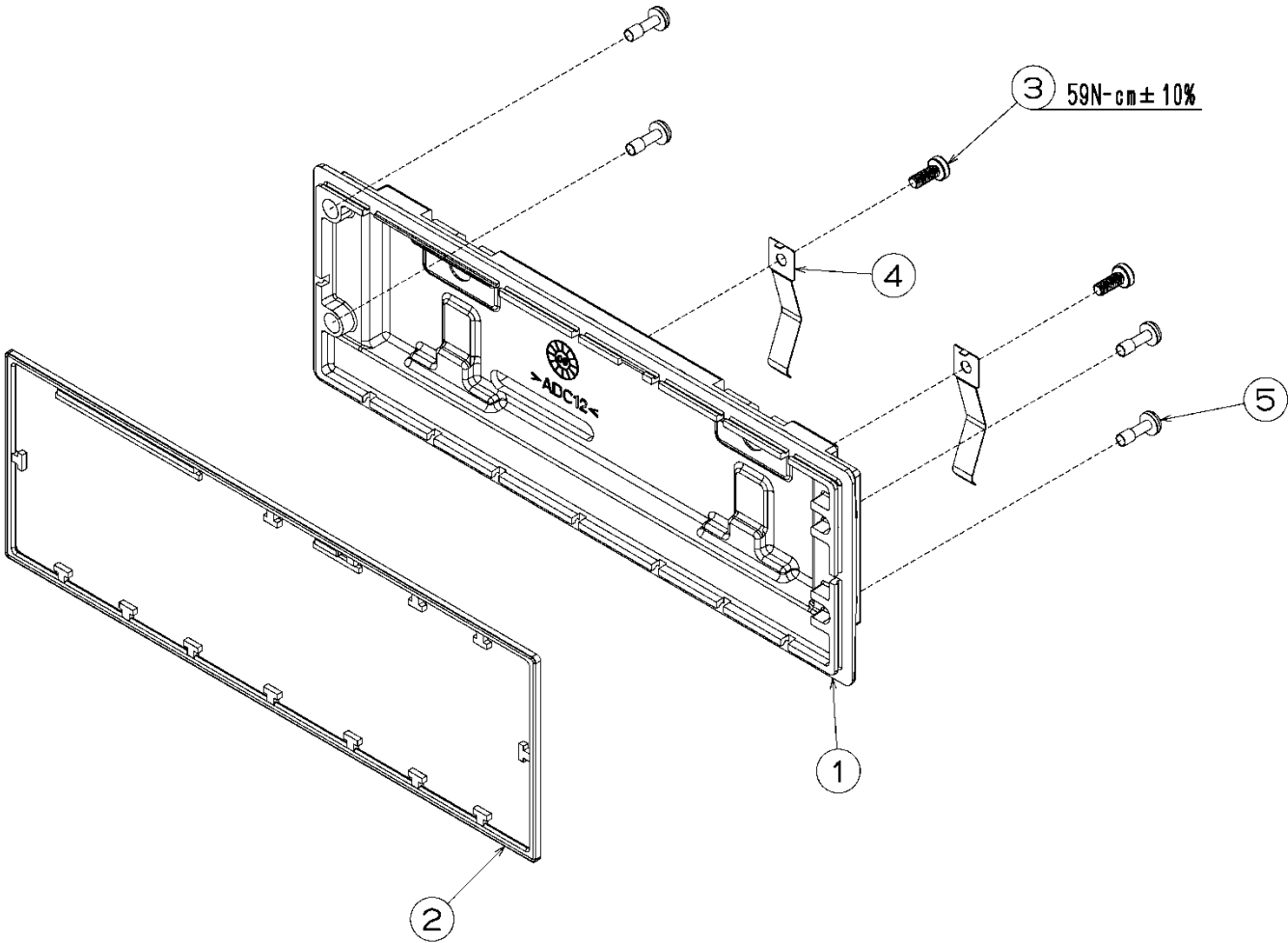
(SPBC05141 Rev. A5)

CH-721 SCAN MODEL FRONT COVER ASSEMBLY
and
CH-721 SYSTEM MODEL FRONT COVER ASSEMBLY

ITEM	DESCRIPTION
1	Cover, front: CH-721 Scan model.
1	Cover, front: CH-721 System model.
2	Control, ramp: CH-721 +/- control.
3	Control, ramp: CH-721 •/•• control.
4	Lightguide, CH-721 Scan model.
4	Lightguide, CH-721 System model.
5	Lightguide, CH-721 preset buttons.
6	Shield, keypad.
7	Knob inner core, volume (includes set screw). See Table 8-1 on page 58.

ITEM	DESCRIPTION
8	Knob inner core, channel (includes set screw). See Table 8-1 on page 58.
9	Gasket, dust (used around display lens).
10	Keypad, CH-721 Scan model.
10	Keypad, CH-721 System model.
11	Keypad, CH-721 preset buttons.
12	Knob cap, channel. See Table 8-1 on page 58.
13	Knob cap, volume. See Table 8-1 on page 58.
14	Gasket, mic connector.
15	Screw, machine: M1.6 x 5.5 millimeter, Phillips-head, self-threading. (Secure lightguides, keypads and ramp controls to front panel; qty. of 19 required.)
16	Screw, machine: M1.6 x 10.5 millimeter, Phillips-head, self-threading. (Secures Keypad Board and Keypad Board's shield to front panel; qty. of 5 required.)
17	Standoff, short. (Qty. of 2 required.)
18	Standoff, long. (Qty. of 2 required.)
19	Seal, O-ring (used with volume control).
20	Assembly, Scan Keypad Board.
20	Assembly, System Keypad Board.
21	Assembly, volume and channel controls with flex strip.
22	Keycap, emergency.
23	Keycap, SCAN.
24	Keycap, A preset.
25	Keycap, B preset.
26	Keycap, C preset.
27	Keycap, OPTION (large, for CH-721 Scan model).
27	Keycap, SYS (small, for CH-721 System model).
28	Keycap, MENU (large, for CH-721 Scan model).
28	Keycap, GRP (small, for CH-721 System model).
29	Keycap, CLEAR (large, for CH-721 Scan model).
29	Keycap, STS (small, for CH-721 System model).
30	Keycap, MSG (small, for CH-721 System model).
31	Keycap, PHN (small, for CH-721 System model).
32	Keycap, DIS (small, for CH-721 System model).
33	Keycap, IND (small, for CH-721 System model).
34	Keycap, MENU (small, for CH-721 System model).
35	Keycap, OPT (small, for CH-721 System model).
36	Keycap, CLR (small, for CH-721 System model).
37	Keycap, blank (small, for CH-721 System model).

9.1.7 CH-721 Rear Housing Assembly for Local Control

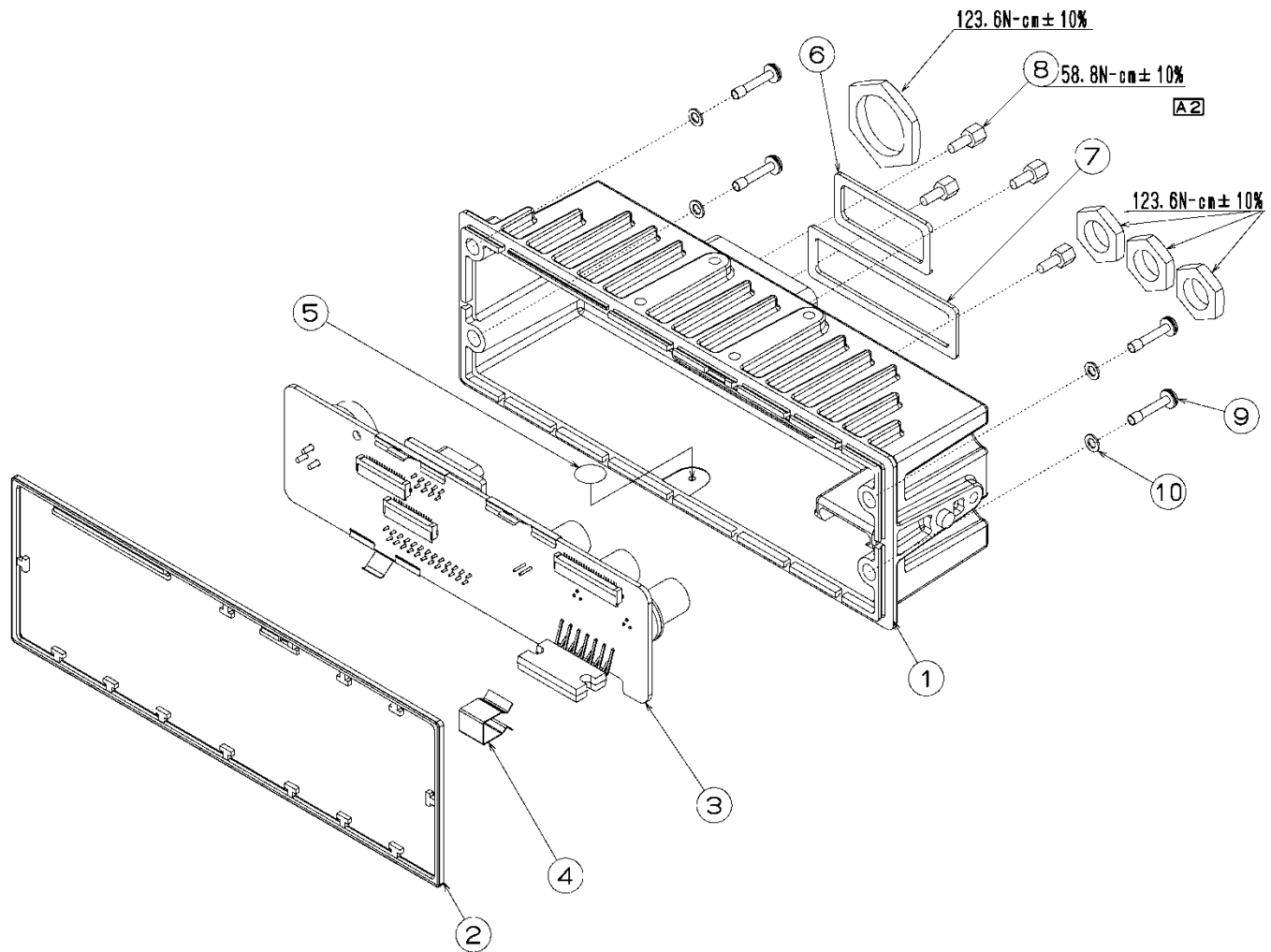


(SPBC05142, Rev. -)

CH-721 REAR HOUSING ASSEMBLY FOR LOCAL CONTROL

ITEM	DESCRIPTION
1	Housing, rear local.
2	Gasket, rubber.
3	Screw, machine: M3 x 5 millimeter with T10 Torx drive pan head. (Qty. of 2 required.)
4	Clip, grounding. (Qty. of 2 required.)
5	Screw, machine: M3 x 9 millimeter with T10 Torx drive pan head, captive. (Qty. of 4 required.)

9.1.8 CH-721 Rear Housing Assembly for Remote Control



(SPBC05140 Rev. A2)

CH-721 REAR HOUSING ASSEMBLY FOR REMOTE CONTROL

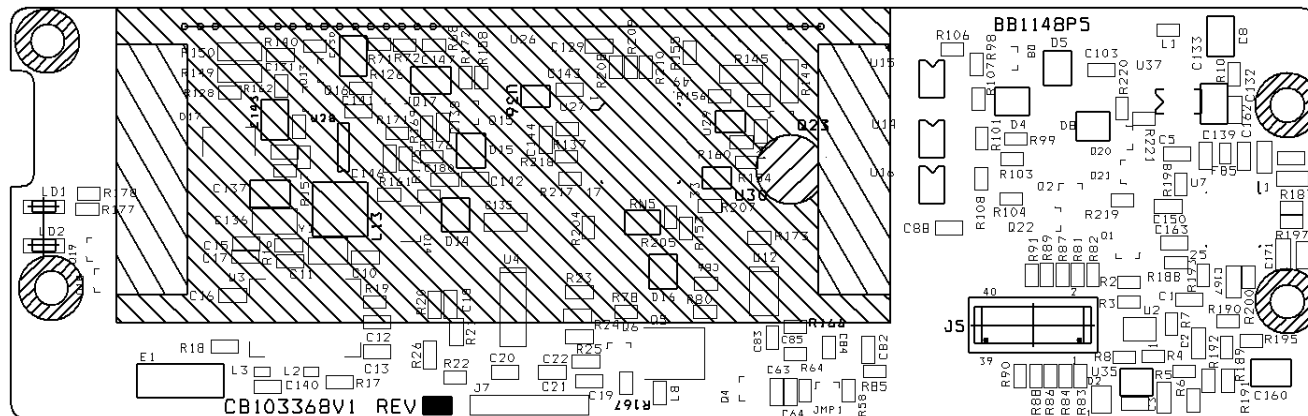
ITEM	DESCRIPTION
1	Housing, rear remote.
2	Gasket, rubber.
3	Assembly, Remote Interface Board. Includes four (4) plastic nuts for Conxall/Switchcraft connectors. (See page 85 for component-level assembly diagram.)
4	Clip, spring. (Secures audio power amplifier U3 to rear housing.)
5	Filter, membrane; similar to Gore-TEX VE40814.
6	Seal, foam rubber, DB-9.
7	Seal, foam rubber, DB-25.
8	Screwlock. (Qty. of 4 required.)
9	Screw, machine: M3 x 15 millimeter with T10 Torx drive pan head, captive. (Qty. of 4 required.)
10	Washer, thrust. (Qty. of 4 required.)

9.2 DISPLAY/DSP BOARD CB103368V1

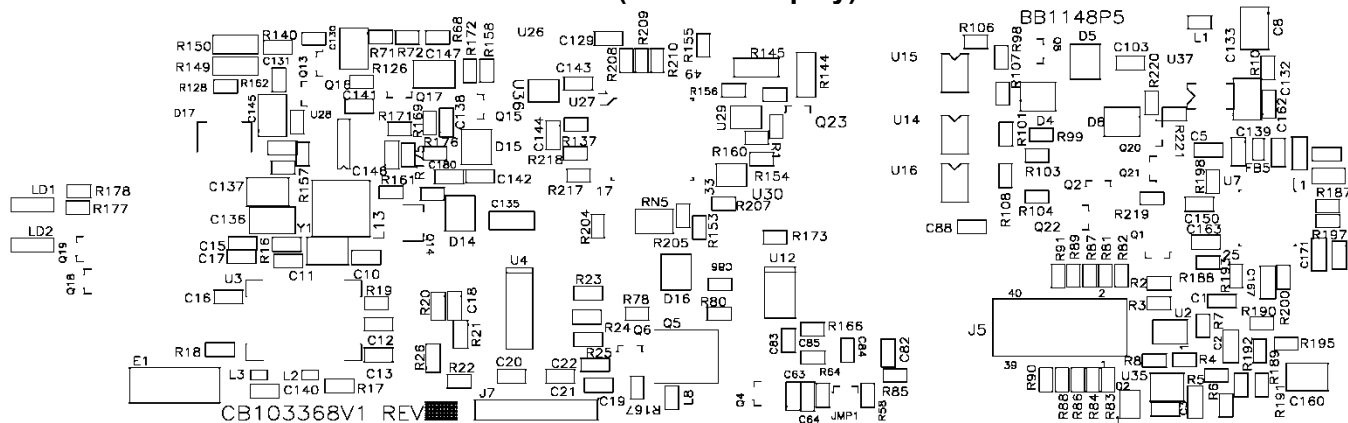


Observe precautions to prevent damage due to **Electro-Static Discharge (ESD)**!

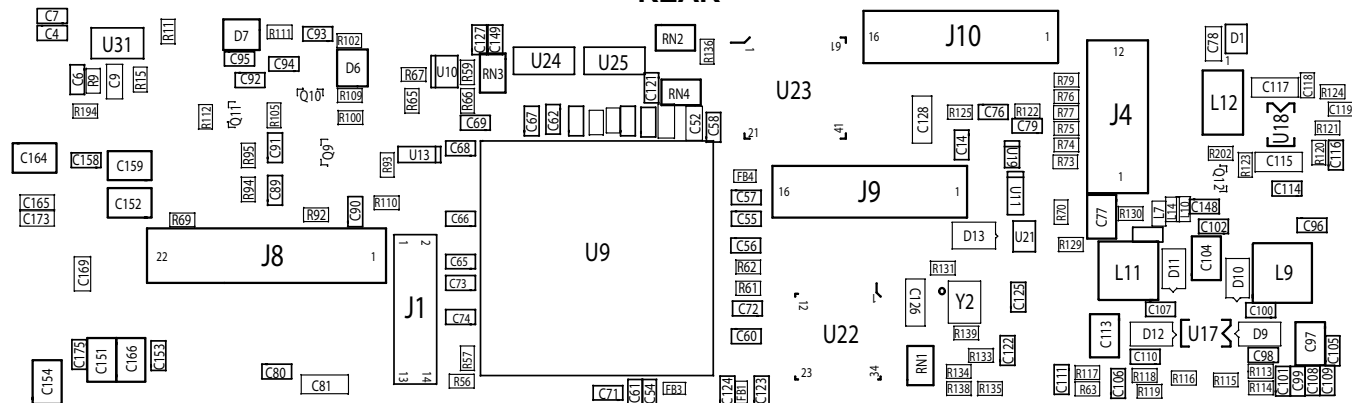
FRONT (With Display)



FRONT (Without Display)



REAR

**DISPLAY/DSP BOARD**
CB103368V1

(Made from PB103368V1 Rev. 01262007)

**DISPLAY/DSP BOARD
CB103368V1, Rev. C**

SYMBOL	DESCRIPTION
-----CAPACITORS-----	
C1	Ceramic: 100 pF $\pm 5\%$ NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
C2 and C3	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C4	Ceramic: 0.22 μ F $\pm 10\%$ X5R, 10 V; similar to Matsushita ECJ1VB1A224K.
C5	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H104K.
C6	Ceramic: 0.22 μ F $\pm 10\%$ X5R, 10 V; similar to Matsushita ECJ1VB1A224K.
C7	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C8	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C9	Ceramic, monolithic: 22 pF $\pm 5\%$ NPO, 50 V; similar to Murata Manufacturing Co. GQM2192C1H220JB01D.
C52 and C53	Ceramic: 10 μ F $\pm 20\%$ X5R, 6.3 V; similar to Matsushita ECJ2FB0J106M.
C54	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H104K.
C55	Ceramic: 1 μ F $\pm 10\%$ X5R, 16 V; similar to Matsushita ECJ1VB1C105K.
C56 thru C75	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H104K.
C76	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C77	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C78	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C79 and C80	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C81	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C82	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C83 thru C86	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H104K.
C88 thru C96	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C97	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.

SYMBOL	DESCRIPTION
C98	Ceramic: 56 pF $\pm 5\%$ NPO, 50 V; similar to Matsushita ECJ1VC1H560J.
C99	Ceramic: 100 pF $\pm 5\%$ NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
C100	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C101	Ceramic: 0.001 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H102K.
C102 and C103	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C104	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C105 thru C107	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C108	Ceramic: 100 pF $\pm 5\%$ NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
C109	Ceramic: 0.001 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H102K.
C110	Ceramic: 68 pF $\pm 5\%$ NPO, 50 V; similar to Matsushita ECJ1VC1H680J.
C111 and C112	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C113	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C114	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C115	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C116	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C117	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C118	Ceramic: 0.001 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H102K.
C121	Ceramic: 1 μ F $\pm 10\%$ X5R, 16 V; similar to Matsushita ECJ1VB1C105K.
C122 and C123	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H104K.
C124	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C125	Ceramic: 0.1 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H104K.
C126	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C127	Ceramic: 0.01 μ F $\pm 10\%$ X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C128	Ceramic: 22 μ F $\pm 20\%$ X5R, 25 V; similar to Matsushita ECJ4YB1E226M.

SYMBOL	DESCRIPTION
C129	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C130	Ceramic: 22 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C131 and C132	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C133	Ceramic: 10 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E106M.
C134	Ceramic: 0.001 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H102K.
C135	Ceramic, monolithic: 0.15 μ F $\pm$ 10% X7R, 50 V; similar to Murata Manufacturing Co. GRM31MB11H154KA01L.
C136 and C137	Ceramic: 22 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C138	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C139	Ceramic: 0.001 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H102K.
C141 and C142	Ceramic: 0.15 μ F $\pm$ 10% X5R, 10 V; similar to Matsushita ECJ1VB1A154K.
C143 and C144	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C145	Ceramic: 10 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E106M.
* C146	Ceramic: 0.47 μ F $\pm$ 10% X5R, 10 V; similar to Matsushita ECJ1VB1A474K.
C147	Ceramic: 1 μ F $\pm$ 10% X5R, 50 V; similar to Matsushita ECJ4YB1H105K.
C148 thru C150	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C151 and C152	Ceramic: 22 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C153	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C154	Ceramic: 22 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C155 and C156	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C158	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C159 and C160	Ceramic: 22 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C162	Ceramic: 0.47 μ F $\pm$ 10% X5R, 10 V; similar to Matsushita ECJ1VB1A474K.

SYMBOL	DESCRIPTION
C163	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C164	Ceramic: 22 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C165	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C166	Ceramic: 22 μ F $\pm$ 20% X5R, 25 V; similar to Matsushita ECJ4YB1E226M.
C167 thru C173	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C174 and C175	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C180	Ceramic: 0.001 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H102K.
* C200	Tantalum: 47 μ F $\pm$ 20%, 10 V; similar to Rohm Semiconductor TCTAL1A476M8R.
----- DIODES -----	
D1 and D2	Array: ESD Protection, 5-element; similar to Vishay GMF05C.
D4 thru D8	Switching, high-speed: 85 V, 100 mA epitaxial planar (2 diodes in series); similar to Toshiba 1SS226.
D9	Rectifier, Schottky: 30 V, 200 mA; similar to ON Semiconductor BAT54T1G or Digi-Key BAT54T1GOSCT-ND.
D12	Rectifier, Schottky: 30 V, 200 mA; similar to ON Semiconductor BAT54T1G or Digi-Key BAT54T1GOSCT-ND.
D13	Zener: 10 V @ 5 mA, 200 mA maximum; similar to NEC RD10M-T1B-A B2.
D14	Switching, high-speed: 80 V, 100 mA epitaxial planar (2 diodes in series); similar to Toshiba 1SS181.
D15 thru D16	Switching, high-speed: 85 V, 100 mA epitaxial planar (2 diodes in series); similar to Toshiba 1SS226.
D17	Schottky barrier: 60 V, 1 A, double-diodes (2 diodes in series with common anodes); similar to Philips BAT160A.
D10 and D11	Rectifier, Schottky: 30 V, 1 A; similar to Fairchild Semiconductor Corp. FBR130.
----- FERRITE BEADS -----	
FB1 thru FB5	Suppressor, EMI: 600 Ω impedance, 0.4 Ω maximum DC resistance, 0.5 A maximum; similar to TDK Corp. MMZ1608S601AT.
----- CONNECTORS / JACKS -----	
J1	Header: 14-pin dual-row with straight pins at 0.1-inch pin spacing, gold-plated; similar to HRS / Hirose Electric Co. A1-14PA-2.54DSA(71).

SYMBOL	DESCRIPTION
J4	Flex-Strip, FPC: 12-contact, zero-insertion force (ZIF) at 1-mm spacing; similar to SMK CFP0512-0201F.
J5	Header, enclosed: 40-pin dual-row with pins at 0.5-mm pin spacing, gold-plated; similar to HRS / Hirose Electric Co. DF17(4.0)-40DP-0.5V.
J7	Header: 6-pin single-row with straight pins at 0.1-inch pin spacing, gold-plated; similar to HRS / Hirose Electric Co. A2-6PA-2.54DSA(71).
J8	Flip-Lock, FPC/FFC: 22-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-22S-1SH(55).
J9 and J10	Flip-Lock, FPC/FFC: 16-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-16S-1SH(55).
----- JUMPERS -----	
JMP1	Strip, terminal: 3-pin single-row, vertical-mounting; similar to Samtec TSM-103-01-T-SV-P-TR.
----- INDUCTORS -----	
L1	Filter, EMI: 2-amp maximum, 0.05 Ω maximum DC resistance, 120 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM18PG121SN1D.
L7 and L8	Filter, EMI: 2-amp maximum, 0.05 Ω maximum DC resistance, 120 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM18PG121SN1D.
L10	Filter, EMI: 2-amp maximum, 0.05 Ω maximum DC resistance, 120 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM18PG121SN1D.
L11	Power, shielded: 4.1 μ H, 2 A maximum; similar to Sumida CDRH5D18NP-4R1NC.
L12	Power: 2.2 μ H, 2.4 A rms maximum, 0.07 Ω maximum DC resistance; similar to Coilcraft DO1608C-222MLC.
L13	Power, shielded: 100 μ H, 360 mA maximum; similar to Sumida CDRH5D18NP-101NC.
L14	Filter, EMI: 2-amp maximum, 0.05 Ω maximum DC resistance, 120 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM18PG121SN1D.
----- LIGHT-EMITTING DIODES -----	
LD1	Red, super-bright; 2 Volts @ 20 mA, 25 mA maximum; similar to Citizen Electronics Co., Ltd. CL-150SR-CD-T.
LD2	Orange, super-bright; 2 Volts @ 20 mA, 25 mA maximum; similar to Citizen Electronics Co., Ltd. CL-150SD-CD-T.
----- TRANSISTORS -----	
Q1	Bi-polar, NPN: 40 V, 200 mA, 200 mW; similar to ON Semiconductor MMBT3904LT1G.
Q2	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM DTA114EKAT146.
Q4	MOSFET, N-channel: 60 V, 115 mA; similar to ON Semiconductor 2N7002LT1G.

SYMBOL	DESCRIPTION
Q5	MOSFET, P-channel HEXFET®: 55 V, 11 A; similar to International Rectifier IRFR9024NTRPBF.
Q6	Driver, NPN: 50 V, 50 mA with built-in bias resistors, inverter configuration; similar to ROHM DTC114EKAT146.
Q8	MOSFET, N-channel: 60 V, 115 mA; similar to ON Semiconductor 2N7002LT1G.
Q9	Bi-polar, NPN: 40 V, 200 mA, 200 mW; similar to ON Semiconductor MMBT3904LT1G.
Q10 and Q11	MOSFET, N-channel: 60 V, 115 mA; similar to ON Semiconductor 2N7002LT1G.
Q12	Driver, NPN: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM DTC114EKAT146.
Q13	MOSFET, N-channel: 60 V, 115 mA; similar to ON Semiconductor 2N7002LT1G.
Q14	MOSFET, N-channel: 60 V, 4 A, 220 M ω maximum on-state resistance; similar to NEC 2SK2857.
Q15	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM DTA114EKAT146.
Q16 and Q17	Driver, NPN: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM DTC114EKAT146.
Q18 and Q19	FET, N-channel: 50 V, 220 mA, 360 mW, enhancement-mode; similar to Fairchild Semiconductor Corp. BSS138.
Q20 and Q21	Bi-polar, NPN: 40 V, 200 mA, 200 mW; similar to ON Semiconductor MMBT3904LT1G.
Q22 and Q23	Driver, NPN: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM DTC114EKAT146.
----- RESISTORS -----	
R1	Thick-film: 47K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF4702V.
R2	Thick-film: 15K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1502V.
R3	Thick-film: 100K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1003V.
R4	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R5	Thick-film: 680 Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF6800V.
R6	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R7	Thick-film: 470K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF4703V.
R8 and R9	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.

SYMBOL	DESCRIPTION
R10 and R11	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R15	Thick-film: 15K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1502V.
* R55	Thick-film: 22K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF2202V.
R56 thru R59	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R61 thru R78	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R79	Thick-film: 499 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF4990V.
R80	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R81 thru R90	Thick-film: 33 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF33R0V.
R91	Thick-film: 499 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF4990V.
R92	Thick-film: 120 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1200V.
R93	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R94	Thick-film: 100K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1003V.
R95	Thick-film: 0 Ω (Jumper), 0.1 W; similar to Matsushita ERJ3GEY0R00V.
R98	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R99	Thick-film: 4.7K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF4701V.
R100	Thick-film: 2.7K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF2701V.
R101 and R102	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R103 and R104	Thick-film: 100 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1000V.
R105	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R106	Thick-film: 1K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1001V.
R107	Thick-film: 2.7K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF2701V.
R108	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R109	Thick-film: 100 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1000V.

SYMBOL	DESCRIPTION
R110	Thick-film: 2.7K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF2701V.
R111 and R112	Thick-film: 100 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1000V.
R113	Thick-film: 30K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF3002V.
R114	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R115 and R116	Thick-film: 22K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF2202V.
R117	Thick-film: 0 Ω (Jumper), 0.1 W; similar to Matsushita ERJ3GEY0R00V.
R118	Thick-film: 41.2K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF4122V.
R119	Thick-film: 24.9K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF2492V.
R120	Thick-film: 750K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF7503V.
R121	Thick-film: 620K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF6203V.
R122	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R123	Thick-film: 220K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF2203V.
R124	Thick-film: 13K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1302V.
R125	Thick-film: 33K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF3302V.
R126	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R128	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R129 thru R131	Thick-film: 100K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1003V.
R133	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R134	Thick-film: 82 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ820V.
R135	Thick-film: 10K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R136	Thick-film: 39 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ390V.
R137	Thick-film: 30 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF30R0V.
R138	Thick-film: 100 Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1000V.
R139	Thick-film: 1K Ω $\pm 1\%$, 0.1 W; similar to Matsushita ERJ3EKF1001V.

SYMBOL	DESCRIPTION
R140	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R141	Thick-film: 0 Ω (Jumper), 0.1 W; similar to Matsushita ERJ3GEY0R00V.
R144 and R145	Thick-film: 5.1 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ5R1V.
R149 and R150	Thick-film: 8.2 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ8R2V.
R153 thru R156	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
* R157	Thick-film: 9.1K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF9101V.
R159	Thick-film: 1M Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1004V.
R158	Thick-film: 22 Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF22R0V.
R160	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R161	Thick-film: 22 Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF22R0V.
R162	Thick-film: 0 Ω (Jumper), 0.1 W; similar to Matsushita ERJ3GEY0R00V.
R163	Thick-film: 150K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1503V.
R164	Thick-film: 2K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF2001V.
R166	Thick-film: 0 Ω (Jumper), 0.1 W; similar to Matsushita ERJ3GEY0R00V.
R169	Thick-film: 27K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF2702V.
R171	Thick-film: 1M Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1004V.
R172	Thick-film: 100K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1003V.
R173	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R175	Thick-film: 4.7K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF4701V.
R176	Thick-film: 330K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF3303V.
R177 and R178	Thick-film: 390 Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF3900V.
R187	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R188	Thick-film: 100 Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1000V.
R189 thru R192	Thick-film: 680 Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF6800V.

SYMBOL	DESCRIPTION
R193	Thick-film: 100 Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1000V.
R194	Thick-film: 12K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1202V.
R195	Thick-film: 82K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF8202V.
R197	Thick-film: 82K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF8202V.
R198	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R200	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R202	Thick-film: 1M Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1004V.
R204 and R205	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R207 thru R210	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
R217 thru R221	Thick-film: 10K Ω $\pm$ 1%, 0.1 W; similar to Matsushita ERJ3EKF1002V.
-----RESISTOR NETWORKS-----	
RN1 thru RN5	Thick-film: 10K Ω $\pm$ 5%, 5-resistor network, 0.05 W per resistor; similar to Matsushita EXBD10C103J.
----- INTEGRATED CIRCUITS -----	
U2	Linear: Rail-to-Rail Low-Power Op Amp; similar to Maxim MAX4245AUT-T.
U3	(Not Installed.)
U4	(Not Installed.)
U7	Digital: 16-Bit Dual-Channel Voice-Band CODEC; similar to Texas Instruments TLV320AIC20KIPFBR.
U9	Digital: DSP with 32-Bit CPU; similar to Texas Instruments TMS320F2812PGFA.
U10	Digital: 8K Byte EEPROM with Serial Peripheral Interface (SPI); similar to Microchip 25LC080AT-I/STG.
U11	Transceiver: CAN; similar to Texas Instruments SN65HVD230DR.
U12	Transceiver: TIA/EIA/RS-232 with Auto-Shutdown; similar to Maxim MAX3221EEAE+T.
U13	Transceiver: TIA/EIA/RS-485/RS-422 Half-Duplex; similar to Sipex SP3072EEN-L/TR.
U14	Linear: Opto-isolator with High-Voltage Darlington Output Transistor; similar to NEC PS2702-1-F3-A.
U15	Linear: Opto-isolator with MOSFET Output Transistor; similar to Toshiba TLP179D.
U16	Linear: Opto-isolator with High-Voltage Darlington Output Transistor; similar to NEC PS2702-1-F3-A.

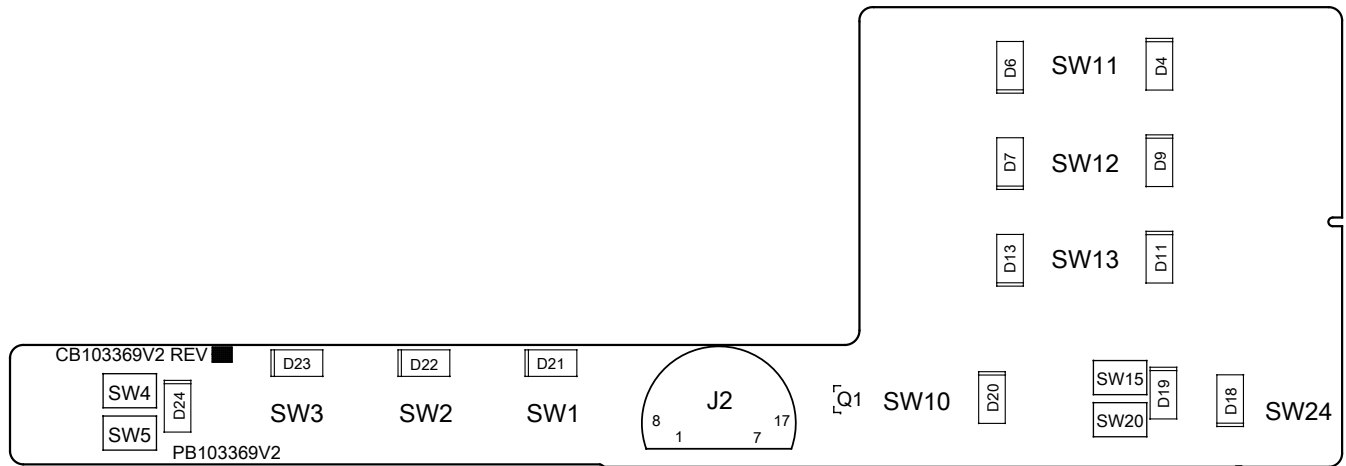
SYMBOL	DESCRIPTION
U17	Linear: Dual Step-Down Switching Voltage Regulator; similar to Linear Technology LT1940EFE.
U18	Linear: Synchronous Step-Down DC/DC Converter; similar to Linear Technology LTC3411EMS.
U19	Digital: Microprocessor Supervisor; similar to Texas Instruments TPS3307DGNR.
U21	Linear: Voltage Comparator with 0.6 V Reference; similar to Analog Devices ADCMP350YKS.
U22	Digital: 64-Macrocell CMOS Programmable Logic Device (CPLD); similar to Xilinx XC2C64A-7VQG44I (Factory Programmed).
U23	Digital: Quad Asynchronous Communication Element (ACE) with 16-Byte FIFOs; similar to Texas Instruments TL16C554AIPNR.
U24	Digital: 3-State Octal Bus Transceiver with 5 V Tolerant Inputs and Outputs; similar to Toshiba TC74LCX245FT.
U25	Digital: Octal Data Latch; similar to Toshiba TC74LCX573FT.
U26	Display, Vacuum-Fluorescent (VFD): 140 x 32 Dot-Matrix; similar to Noritake 7000-Series NM14032AC.
U27	Digital: 16-Bit Microcomputer with 16 KB Flash ROM; similar to Hitachi/Renesas HD64F3672FP. (Factory Programmed)

SYMBOL	DESCRIPTION
U28	Linear: Switching Voltage Regulator Controller; similar to New JRC Ltd. NJM2377M.
U29	Digital: Single 2-Input OR Gate; similar to Toshiba TC7SET32FU.
U30	Digital: Single 3-State Bus Buffer; similar to Texas Instruments SN74LVC1G125DCK.
U31	Linear: 3-Watt Audio Power Amplifier; similar to National Semiconductor LM4871MM/NOPB.
U35	Linear: 5 V 100-mA Low Drop-Out (LDO) Voltage Regulator; similar to Linear Technology LT1761ES5-BYP.
U36	Digital: Single 2-Input OR Gate; similar to Toshiba TC7SET32FU.
U37	Digital: Programmable Clock Generator; similar to Cypress CY22050ZXI. (Factory Programmed)
----- OSCILLATORS -----	
Y2	Module, crystal: 24 MHz $\pm$ 30 ppm; similar to NDK 2725T-24.000MHZ-15PF-30PPM.

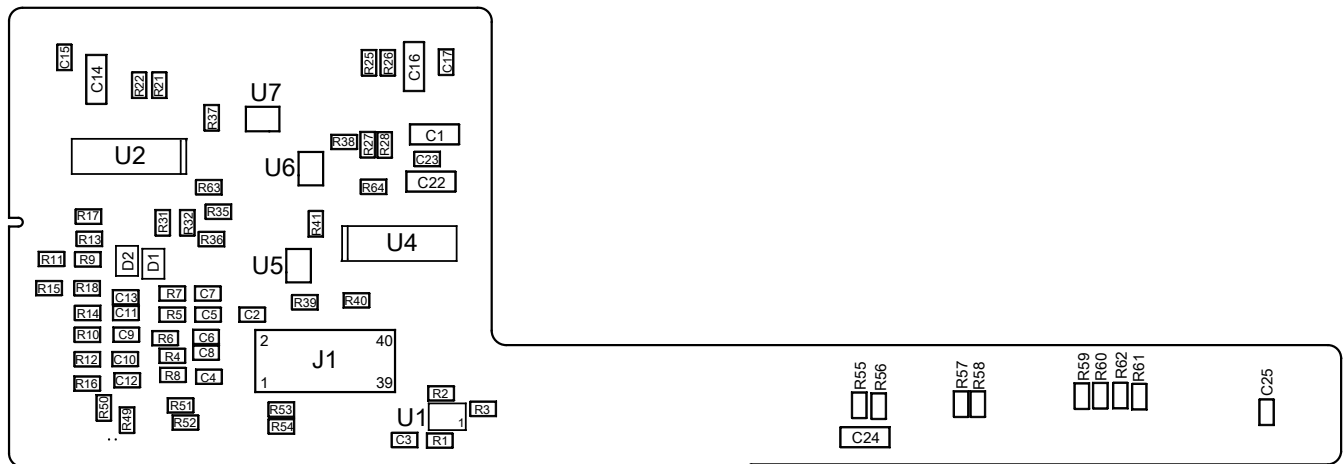
* Components added, deleted or changed by Production Changes.

9.3 SCAN KEYPAD BOARD CB103369V2

FRONT



REAR



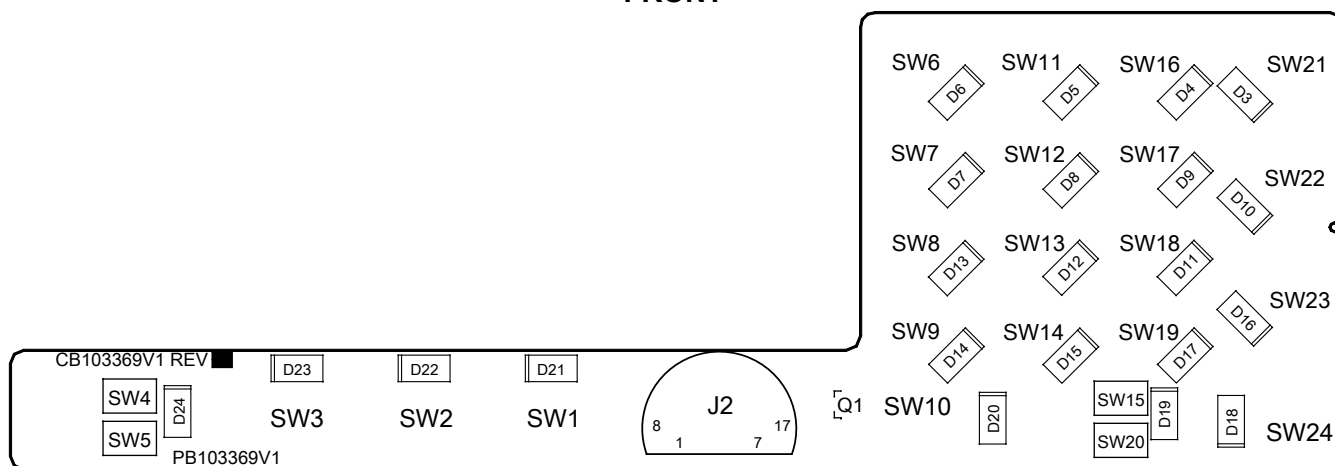
Observe precautions
to prevent damage due
to **Electro-Static Dis-**
charge (**ESD**)!

SCAN KEYPAD BOARD
CB103369V2

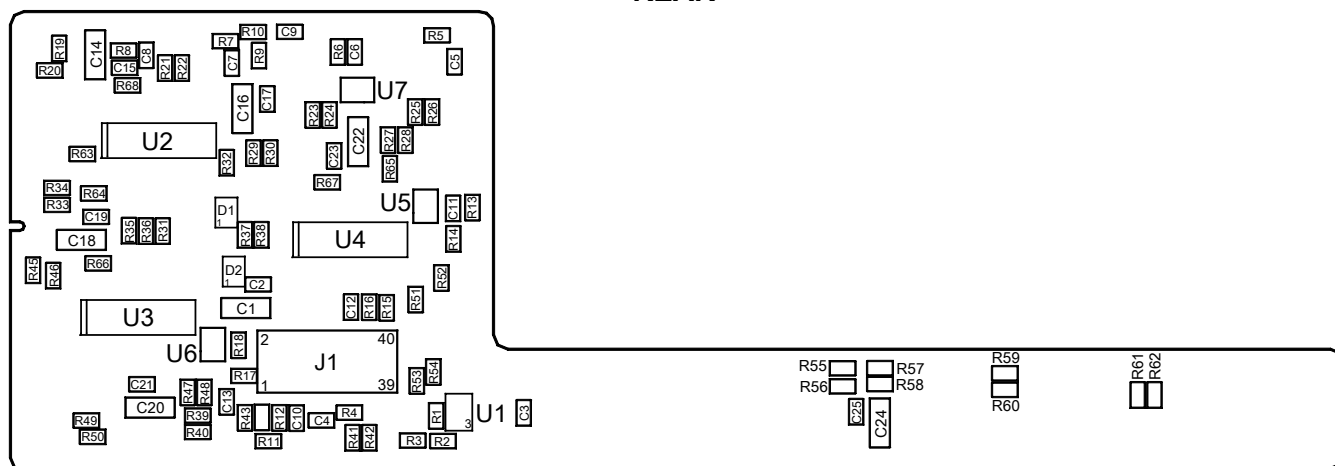
(PB103369V2 Rev. 20070309)

9.4 SYSTEM KEYPAD BOARD CB103369V1

FRONT



REAR



Observe precautions to prevent damage due to **Electro-Static Discharge (ESD)**!

SYSTEM KEYPAD BOARD CB103369V1

(PB103369V1 Rev. 20070309)

**SCAN KEYPAD BOARD
CB103369V2, Rev. B
and
SYSTEM KEYPAD BOARD
CB103369V1, Rev. B**

SYMBOL	DESCRIPTION
-----CAPACITORS-----	
C1	Ceramic, monolithic: 10 μ F $\pm$ 10%, 25 V; similar to Murata Manufacturing Co. GRM31CB31E106KA75L.
C2 and C3	Ceramic, monolithic: 0.01 μ F $\pm$ 10%, 50 V; similar to Murata Manufacturing Co. GRM188B11H103KA01D.
C4 thru C13	Ceramic, monolithic: 47 pF $\pm$ 5%, 0 $\pm$ 60 ppm/ $^{\circ}$ C, 50 V; similar to Murata Manufacturing Co. GRM1882C1H470JA01D.
C14	Ceramic, monolithic: 10 μ F $\pm$ 10%, 25 V; similar to Murata Manufacturing Co. GRM31CB31E106KA75L.
C15	Ceramic, monolithic: 0.01 μ F $\pm$ 10%, 50 V; similar to Murata Manufacturing Co. GRM188B11H103KA01D.
C16	Ceramic, monolithic: 10 μ F $\pm$ 10%, 25 V; similar to Murata Manufacturing Co. GRM31CB31E106KA75L.
C17	Ceramic, monolithic: 0.01 μ F $\pm$ 10%, 50 V; similar to Murata Manufacturing Co. GRM188B11H103KA01D.
C18	Ceramic, monolithic: 10 μ F $\pm$ 10%, 25 V; similar to Murata Manufacturing Co. GRM31CB31E106KA75L. (Used on System Keypad Board CB103369V1.)
C19	Ceramic, monolithic: 0.01 μ F $\pm$ 10%, 50 V; similar to Murata Manufacturing Co. GRM188B11H103KA01D. (Used on System Keypad Board CB103369V1.)
C20	Ceramic, monolithic: 10 μ F $\pm$ 10%, 25 V; similar to Murata Manufacturing Co. GRM31CB31E106KA75L. (Used on System Keypad Board CB103369V1.)
C21	Ceramic, monolithic: 0.01 μ F $\pm$ 10%, 50 V; similar to Murata Manufacturing Co. GRM188B11H103KA01D. (Used on System Keypad Board CB103369V1.)
C22	Ceramic, monolithic: 10 μ F $\pm$ 10%, 25 V; similar to Murata Manufacturing Co. GRM31CB31E106KA75L.
C23	Ceramic, monolithic: 0.01 μ F $\pm$ 10%, 50 V; similar to Murata Manufacturing Co. GRM188B11H103KA01D.
C24	Ceramic, monolithic: 10 μ F $\pm$ 10%, 25 V; similar to Murata Manufacturing Co. GRM31CB31E106KA75L.
C25	Ceramic, monolithic: 0.01 μ F $\pm$ 10%, 50 V; similar to Murata Manufacturing Co. GRM188B11H103KA01D.
-----DIODES-----	
D1 and D2	Array: ESD Protection, 5-element ; similar to Vishay GMF05C.
-----LIGHT-EMITTING DIODES-----	
D3 thru D24	Bicolor: Red/Green; similar to Avago Technologies HSMF-C155.

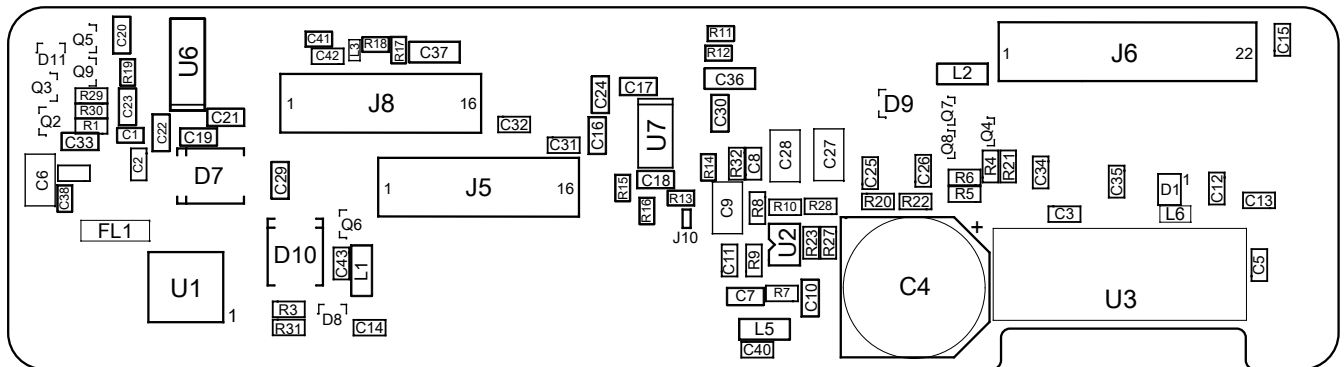
SYMBOL	DESCRIPTION
-----CONNECTORS / JACKS-----	
J1	Header, enclosed: 40-pin dual-row with pins at 0.5-mm pin spacing, gold-plated; similar to HRS / Hirose Electric Co. DF17(4.0)-40DS-0.5V(57).
J2	Header: 17-pin; similar to Maxes H-7JEPD0003.
-----TRANSISTORS-----	
Q1	Phototransistor: 60-degree light sensor; similar to OSRAM SFH3410-1/2.
-----RESISTORS-----	
R1 thru R3	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V.
R4 thru R8	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R9	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R10	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R11	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R12	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R13	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R14	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R15	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R16	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R17	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R18	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R19 and R20	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V. (Used on System Keypad Board CB103369V1.)
R21 thru R28	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V.
R29 and R30	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V. (Used on System Keypad Board CB103369V1.)
R31 thru R36	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V.
R37	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V. (Used on Scan Keypad Board CB103369V2.)

SYMBOL	DESCRIPTION
R37	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V. (Used on System Keypad Board CB103369V1.)
R38	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V. (Used on Scan Keypad Board CB103369V2.)
R38	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V. (Used on System Keypad Board CB103369V1.)
R39 and R40	Thick-film: 270 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ271V. (Used on System Keypad Board CB103369V1.)
R41	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V. (Used on Scan Keypad Board CB103369V2.)
R41	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V. (Used on System Keypad Board CB103369V1.)
R42 thru R44	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V. (Used on System Keypad Board CB103369V1.)
R45 and R46	Thick-film: 500 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ501V. (Used on System Keypad Board CB103369V1.)
R47 and R48	Thick-film: 1K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ102V. (Used on System Keypad Board CB103369V1.)
R49 thru R62	Thick-film: 270 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ271V.
R63 and R64	Thick-film: 240 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ241V. (Used on Scan Keypad Board CB103369V2.)
R63 thru R65	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V. (Used on System Keypad Board CB103369V1.)
R66 thru R68	Thick-film: 240 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ241V. (Used on System Keypad Board CB103369V1.)

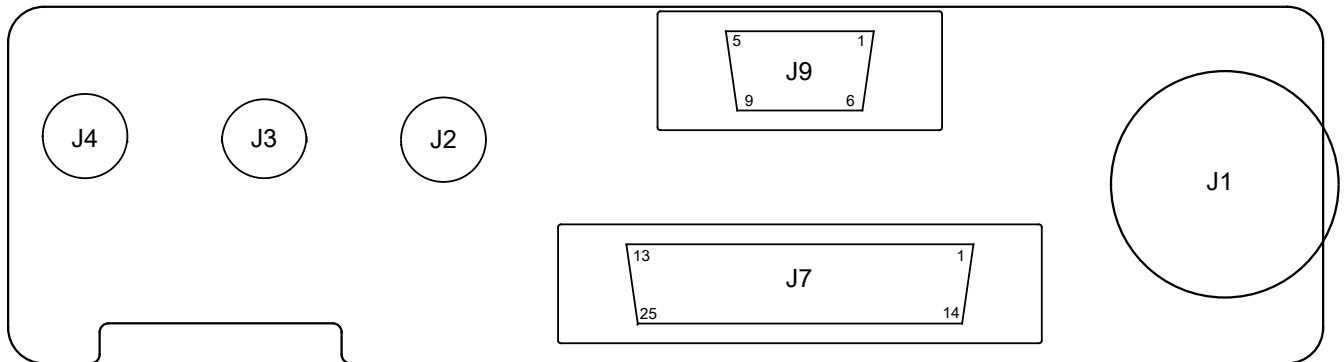
SYMBOL	DESCRIPTION
----- SWITCHES -----	
SW1 thru SW3	Made from/Parts of printed circuit board and respective snap-dome.
SW4 and SW5	Pushbutton: Tactile-feel, 3.9 x 2.9 x 2.0 mm; similar to Alps Electric Inc. SKRKAEE010.
SW6 thru SW14	Made from/Parts of printed circuit board and respective snap-dome.
SW15	Pushbutton: Tactile-feel, 3.9 x 2.9 x 2.0 mm; similar to Alps Electric Inc. SKRKAEE010.
SW16 thru SW19	Made from/Parts of printed circuit board and respective snap-dome.
SW20	Pushbutton: Tactile-feel, 3.9 x 2.9 x 2.0 mm; similar to Alps Electric Inc. SKRKAEE010.
SW21 thru SW24	Made from/Parts of printed circuit board and respective snap-dome.
----- INTEGRATED CIRCUITS -----	
U1	Linear: 16-Bit Shift Register/Latch with Constant-Current Output Drivers; similar to Toshiba TB62706BFG.
U2	Digital: 16-Bit Shift Register/Latch with Constant-Current Output Drivers; similar to Toshiba TB62706BFG.
U3	Digital: 16-Bit Shift Register/Latch with Constant-Current Output Drivers; similar to Toshiba TB62706BFG. (Used on System Keypad Board CB103369V1.)
U4	Digital: 16-Bit Shift Register/Latch with Constant-Current Output Drivers; similar to Toshiba TB62706BFG.
U5 thru U7	Digital: Single 2-Input OR Gate; similar to Toshiba TC7SET32FU.

9.5 REMOTE INTERFACE BOARD CB23224-0001 Rev. C and Earlier

FRONT



REAR



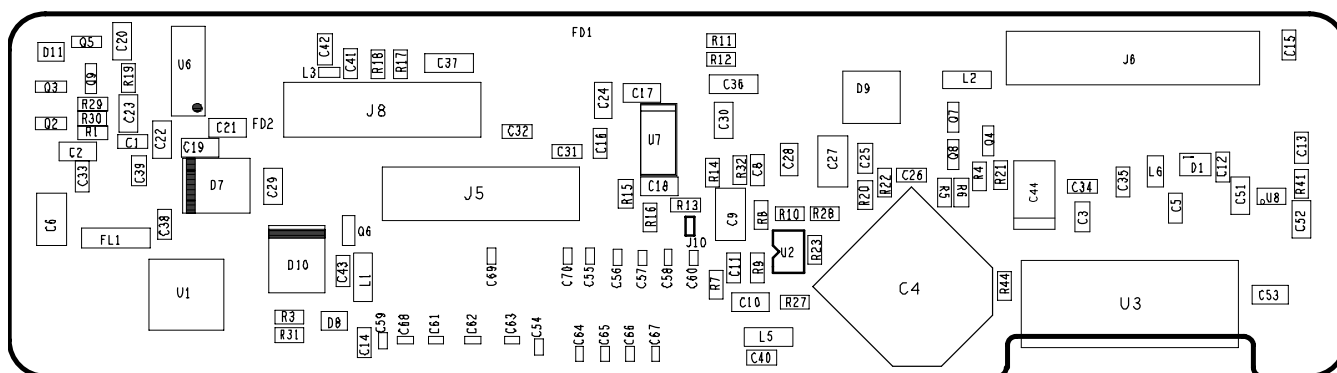
Observe precautions to prevent damage due to **Electro-Static Discharge (ESD)**!

**REMOTE INTERFACE BOARD
CB23224-0001 Rev. C and Earlier**

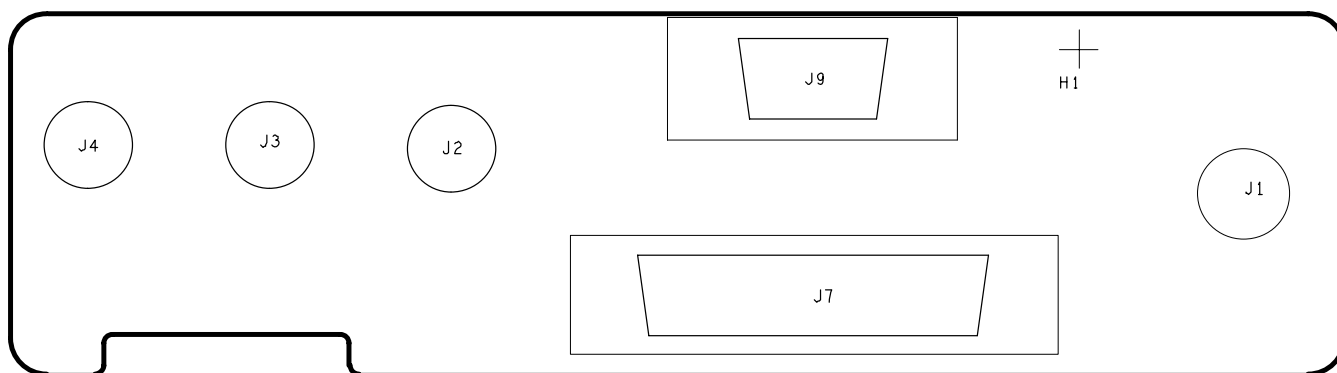
(PB103369V2 Rev. 20070309)

9.6 REMOTE INTERFACE BOARD CB23224-0001 (Rev. D)

FRONT



REAR



Observe precautions
to prevent damage due
to **Electro-Static Dis-**
charge (**ESD**)!

REMOTE INTERFACE BOARD CB23224-0001 (Rev. D)

(CB23224-0001 Rev. D)

REMOTE INTERFACE BOARD CB23224-0001, Rev. C

SYMBOL	DESCRIPTION
-----CAPACITORS-----	
C1	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C2	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C3	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C4	Electrolytic: 330 μ F $\pm$ 20%, 35 V; similar to Matsushita EEVTG1V331Q.
C5	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C6	(Not Installed.)
C7	Ceramic: 0.22 μ F $\pm$ 10% X5R, 25 V; similar to Matsushita ECJ2FB1E224K.
C8	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C9	Ceramic: 22 μ F $\pm$ 20% X5R, 10 V; similar to Taiyo Yuden LMK325BJ226MM-T.
C10	Ceramic: 0.47 μ F $\pm$ 10% X5R, 16 V; similar to Matsushita ECJ2FB1C474K.
C11	Ceramic: 2200 pF $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H222K.
C12 and C13	Ceramic: 100 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
C14 and C15	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C16 thru C24	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C25 and C26	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C27	(Not Installed.)
C28	Ceramic: 10 μ F $\pm$ 10% X5R, 16 V; similar to Taiyo Yuden EMK316BJ106KL-T.
C29 thru C30	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
* C31 and * C32	Ceramic: 0.47 μ F $\pm$ 10% X5R, 10 V; similar to Matsushita ECJ1VB1A474K.
C33	(Not Installed.)
C34 and C35	Ceramic: 100 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H101J.

SYMBOL	DESCRIPTION
C36 and C37	Ceramic: 10 μ F $\pm$ 10% X5R, 16 V; similar to Taiyo Yuden EMK316BJ106KL-T.
C38 thru C41	(Not Installed.)
C42	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C43	Ceramic: 100 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
C54 thru C68	Ceramic: 820 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H821J.
-----DIODES-----	
D1	Array: ESD Protection, 6.8 V, 5-element; similar to Toshiba DF7A6.8CFU.
D7	Rectifier, Schottky: 3 A, 40 V; similar to ON Semiconductor MBRS340T3G.
D8	Switching, high-speed: 85 V, 100 mA epitaxial planar (2 diodes in series); similar to Toshiba 1SS226.
D9	Rectifier, Schottky: 1 A, 60 V; similar to NXP Semiconductors BAT160A,115.
D10	Rectifier, Schottky: 3 A, 40 V; similar to ON Semiconductor MBRS340T3G.
D11	Switching, high-speed: 85 V, 100 mA epitaxial planar (2 diodes in series); similar to Toshiba 1SS226.
-----FILTER-----	
FL1	Filter, Low-Pass: 2-Amp; similar to Murata NFE61HT361C2A9L.
-----CONNECTORS / JACKS-----	
J1	Receptacle, weatherproof: 3-pin male; similar to Conxall/Switchcraft 4181-3PG-300.
* J2	Receptacle, weatherproof: 2-pin female; similar to Conxall M9038R-BR..
* J3 and * J4	Receptacle, weatherproof: 3-pin female; similar to Conxall M9036R-BR.
J5	Flip-Lock, FPC/FFC: 16-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-16S-1SH(55).
J6	Flip-Lock, FPC/FFC: 22-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-22S-1SH(55).
J7	Receptacle: Female DB-25 with threaded inserts, gold-plated pins, straight-mount; similar to Tyco/AMP 5745967-8.
J7-1	Screwlock: #4-40 nut and M2.6 threads with lock and flat washers; similar to Tyco/AMP 176152-1.
J8	Flip-Lock, FPC/FFC: 16-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-16S-1SH(55).

SYMBOL	DESCRIPTION
J9	Receptacle: Female DB-9 with threaded inserts, gold-plated pins, straight-mount; similar to Tyco/AMP 5747150-8.
J9-1	Screwlock: #4-40 nut and M2.6 threads with lock and flat washers; similar to Tyco/AMP 176152-1.
J10	(Not Installed.)
----- INDUCTORS -----	
L1 and L2	Filter, EMI: 3-amp maximum, 0.025 Ω maximum DC resistance, 50 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM31PG500SH1L.
L3	Filter, EMI: 300-milliamp maximum, 0.1 Ω maximum DC resistance, 10 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM15BB100SN1D.
L5	Filter, EMI: 3-amp maximum, 0.025 Ω maximum DC resistance, 50 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM31PG500SH1L.
L6	Filter, EMI: 80-milliamp maximum, 1.6 Ω maximum DC resistance, 2200 Ω common-mode impedance @ 100 MHz; similar to Murata Manufacturing Co. DLW31SH222SQ2L.
----- TRANSISTORS -----	
Q2	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM Semiconductor DTA114EKAT146.
Q3	Digital NPN: 50V, 50 mA with built-in bias resistors, similar to ROHM Semiconductor DTC114EKAT146.
Q4	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM Semiconductor DTA114EKAT146.
Q5 thru Q8	Digital NPN: 50V, 50 mA with built-in bias resistors, similar to ROHM Semiconductor DTC114EKAT146.
Q9	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM Semiconductor DTA114EKAT146.
----- RESISTORS -----	
R1	Thick-film: 10 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R3	Thick-film: 27K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ273V.
R4	Thick-film: 10 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R5	Thick-film: 100K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ104V.
R6	Thick-film: 5.6K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ562V.
R7 thru R10	Thick-film: 4.7K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ472V.
R11 thru R12	Thick-film: 10K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ103V.

SYMBOL	DESCRIPTION
R13 thru R16	Thick-film: 100 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R17 thru R19	Thick-film: 10K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R20	Thick-film: 100K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ104V.
R21	Thick-film: 10K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R22	Thick-film: 100K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ104V.
R23	Thick-film: 10K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R27 and R28	(Not Installed.)
R29	Thick-film: 10 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R30	Thick-film: 10K Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R31	Thick-film: 10 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R32	Thick-film: 100 Ω $\pm 5\%$, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
----- INTEGRATED CIRCUITS -----	
U1	Linear: High-Side MOSFET Driver, 2.5 A, 36 V; similar to STMicroelectronics VN751PT or VN751PT13TR.
U2	Linear: Rail-to-Rail Low-Power Op Amp; similar to Maxim MAX4246AKA+T.
* U3	Linear: 2 x 40-Watt Audio Amplifier; similar to Philips TDA8563AQ.
U6	Digital: TIA/EIA/RS-232 Transceiver (5 Drivers & 3 Receivers); similar to Sipex SP3238EEA-L or SP3238EEA-L/TR.
U7	Digital: TIA/EIA/RS-232 Transceiver (2 Drivers & 2 Receivers); similar to Sipex SP3223EBEA-L or SP3223EBEA-L/TR.
----- MISCELLANEOUS -----	
	Clip, Edge; similar to JRC MJYW12530. (Qty. = 3)

* Components added, deleted or changed by Production Changes.

REMOTE INTERFACE BOARD CB23224-0001, Rev. D

SYMBOL	DESCRIPTION
-----CAPACITORS-----	
C1	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C2	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C3	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C4	Electrolytic: 330 μ F $\pm$ 20%, 35 V; similar to Matsushita EEVTG1V331Q.
C5	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C6	(Not Installed.)
* C7	(Not Installed.)
C8	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C9	Ceramic: 22 μ F $\pm$ 20% X5R, 10 V; similar to Taiyo Yuden LMK325BJ226MM-T.
C10	Ceramic: 0.47 μ F $\pm$ 10% X5R, 16 V; similar to Matsushita ECJ2FB1C474K.
* C11	Ceramic: 820 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H821J.
C12 and C13	Ceramic: 100 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
C14 and C15	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C16 thru C24	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C25 and C26	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C27	(Not Installed.)
C28	Ceramic: 10 μ F $\pm$ 10% X5R, 16 V; similar to Taiyo Yuden EMK316BJ106KL-T.
C29 thru C30	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
* C31 and * C32	Ceramic: 0.47 μ F $\pm$ 10% X5R, 16 V; similar to Matsushita ECJ2FB1C474K.
C33	(Not Installed.)
C34 and C35	Ceramic: 100 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
C36 and C37	Ceramic: 10 μ F $\pm$ 10% X5R, 16 V; similar to Taiyo Yuden EMK316BJ106KL-T.

SYMBOL	DESCRIPTION
C38 thru C41	(Not Installed.)
C42	Ceramic: 0.01 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ1VB1H103K.
C43	Ceramic: 100 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H101J.
* C44	Tantalum: 33 μ F $\pm$ 10%, 16 V; similar to Kemet T491C336K016AT.
C51	Ceramic: 0.1 μ F $\pm$ 10% X7R, 50 V; similar to Matsushita ECJ2FB1H104K.
C53	Ceramic: 0.22 μ F $\pm$ 10% X7R, 25 V; similar to Matsushita ECJ2FB1E224K.
* C52	Ceramic: 0.47 μ F $\pm$ 10% X5R, 16 V; similar to Matsushita ECJ2FB1C474K.
* C54 thru * C70	Ceramic: 820 pF $\pm$ 5% NPO, 50 V; similar to Matsushita ECJ1VC1H821J.
-----DIODES-----	
D1	Array: ESD Protection, 6.8 V, 5-element; similar to Toshiba DF7A6.8CFU.
D7	Rectifier, Schottky: 3 A, 40 V; similar to ON Semiconductor MBRS340T3G.
D8	Switching, high-speed: 85 V, 100 mA epitaxial planar (2 diodes in series); similar to Toshiba 1SS226.
D9	Rectifier, Schottky: 1 A, 60 V; similar to NXP Semiconductors BAT160A,115.
D10	Rectifier, Schottky: 3 A, 40 V; similar to ON Semiconductor MBRS340T3G.
D11	Switching, high-speed: 85 V, 100 mA epitaxial planar (2 diodes in series); similar to Toshiba 1SS226.
-----FILTER-----	
FL1	Filter, Low-Pass: 2-Amp; similar to Murata NFE61HT361C2A9L.
-----CONNECTORS / JACKS-----	
J1	Receptacle, weatherproof: 3-pin male; similar to Conxall/Switchcraft 4181-3PG-300.
* J2	Receptacle, weatherproof: 2-pin female; similar to Conxall M9038R-BR..
* J3 and * J4	Receptacle, weatherproof: 3-pin female; similar to Conxall M9036R-BR.
J5	Flip-Lock, FPC/FFC: 16-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-16S-1SH(55).
J6	Flip-Lock, FPC/FFC: 22-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-22S-1SH(55).

SYMBOL	DESCRIPTION
J7	Receptacle: Female DB-25 with threaded inserts, gold-plated pins, straight-mount; similar to Tyco/AMP 5745967-8.
J7-1	Screwlock: #4-40 nut and M2.6 threads with lock and flat washers; similar to Tyco/AMP 176152-1.
J8	Flip-Lock, FPC/FFC: 16-contact with contacts on bottom at 1-mm spacing, gold-plated; similar to HRS / Hirose Electric Co. FH12-16S-1SH(55).
J9	Receptacle: Female DB-9 with threaded inserts, gold-plated pins, straight-mount; similar to Tyco/AMP 5747150-8.
J9-1	Screwlock: #4-40 nut and M2.6 threads with lock and flat washers; similar to Tyco/AMP 176152-1.
J10	(Not Installed.)
----- INDUCTORS -----	
L1 and L2	Filter, EMI: 3-amp maximum, 0.025 Ω maximum DC resistance, 50 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM31PG500SH1L.
L3	Filter, EMI: 300-milliamp maximum, 0.1 Ω maximum DC resistance, 10 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM15BB100SN1D.
L5	Filter, EMI: 3-amp maximum, 0.025 Ω maximum DC resistance, 50 Ω impedance @ 100 MHz; similar to Murata Manufacturing Co. BLM31PG500SH1L.
L6	Filter, EMI: 80-milliamp maximum, 1.6 Ω maximum DC resistance, 2200 Ω common-mode impedance @ 100 MHz; similar to Murata Manufacturing Co. DLW31SH222SQ2L.
----- TRANSISTORS -----	
Q2	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM Semiconductor DTA114EKAT146.
Q3	Digital NPN: 50V, 50 mA with built-in bias resistors, similar to ROHM Semiconductor DTC114EKAT146.
Q4	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM Semiconductor DTA114EKAT146.
Q5 thru Q8	Digital NPN: 50V, 50 mA with built-in bias resistors, similar to ROHM Semiconductor DTC114EKAT146.
Q9	Driver, PNP: 50 V, 100 mA with built-in bias resistors, inverter configuration; similar to ROHM Semiconductor DTA114EKAT146.
----- RESISTORS -----	
R1	Thick-film: 10 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R3	Thick-film: 27K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ273V.
R4	Thick-film: 10 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R5	Thick-film: 100K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ104V.

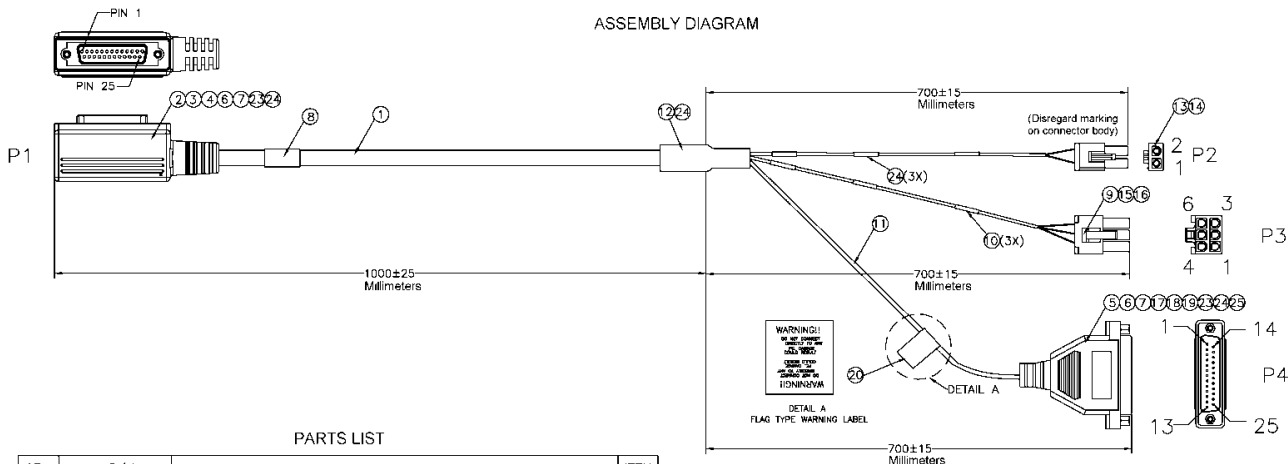
SYMBOL	DESCRIPTION
* R6	Thick-film: 10 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
* R7	Thick-film: 18K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ183V.
R8	Thick-film: 4.7K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ472V.
* R9	Thick-film: 11K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ113V.
R10	Thick-film: 4.7K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ472V.
R11 thru R12	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R13 thru R16	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
R17 thru R19	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R20	Thick-film: 100K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ104V.
R21	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R22	Thick-film: 100K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ104V.
R23	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R27 and R28	(Not Installed.)
R29	Thick-film: 10 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R30	Thick-film: 10K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ103V.
R31	Thick-film: 10 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ100V.
R32	Thick-film: 100 Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ101V.
* R41	Thick-film: 100K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ104V.
* R44	Thick-film: 56K Ω $\pm$ 5%, 0.1 W; similar to Matsushita ERJ3GEYJ563V.
----- INTEGRATED CIRCUITS -----	
U1	Linear: High-Side MOSFET Driver, 2.5 A, 36 V; similar to STMicroelectronics VN751PT or VN751PT13TR.
U2	Linear: Rail-to-Rail Low-Power Op Amp; similar to Maxim MAX4246AKA+T.
* U3	Linear: Audio Amplifier; similar to TDA7391.
U6	Digital: TIA/EIA/RS-232 Transceiver (5 Drivers & 3 Receivers); similar to Sipex SP3238EEA-L or SP3238EEA-L/TR.

SYMBOL	DESCRIPTION
U7	Digital: TIA/EIA/RS-232 Transceiver (2 Drivers & 2 Receivers); similar to Sipex SP3223EBEA-L or SP3223EBEA-L/TR.
* U8	Analog: Switch, SPST Normally-Open; similar to Texas Instruments TS5A4594DBV. ----- MISCELLANEOUS ----- Clip, Edge; similar to JRC MJYW12530. (Qty. = 3) Clip, C; similar to L3Harris 14007-0107-01.

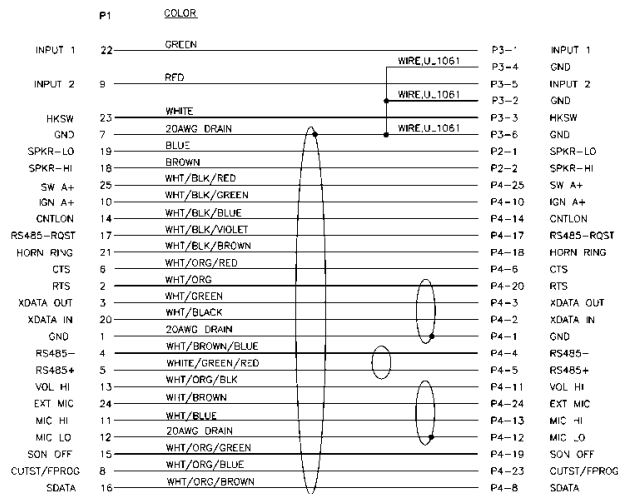
* Components added, deleted or changed by Production Changes.

10 OPTIONAL CABLES

10.1 CH-721 OPTION CABLE CA-011854-001



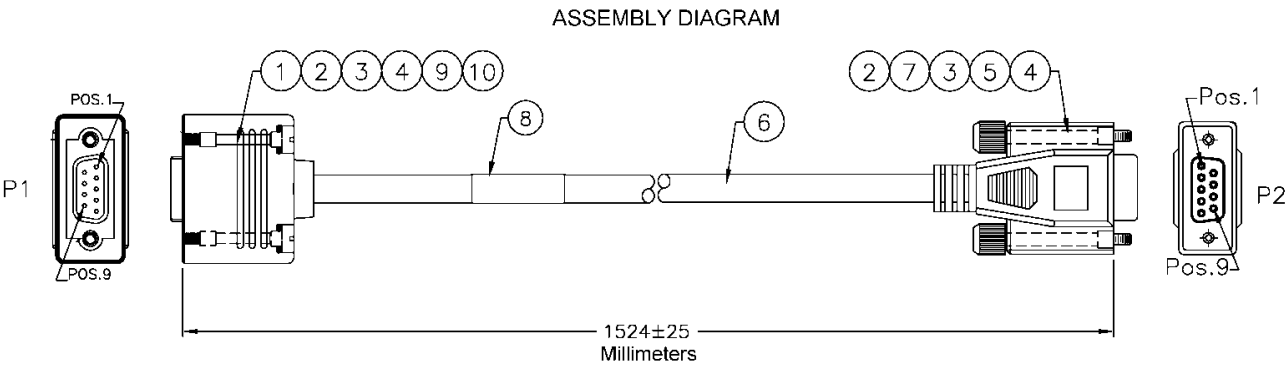
WIRING DIAGRAM



CH-721 OPTION CABLE CA-011854-001

(Made From PS-CA-011854 Rev. D)

10.2 CH-721 PROGRAMMING CABLE CA-104861



WIRING LIST

P1	COLOR	P2
1	BLACK	1
2	BROWN	2
3	RED	3
4	ORANGE	4
5	BLUE	5
6	YELLOW	6
7	PURPLE	7
8	GREEN	8
9	GRAY	9
SHELL	SHIELD	SHELL

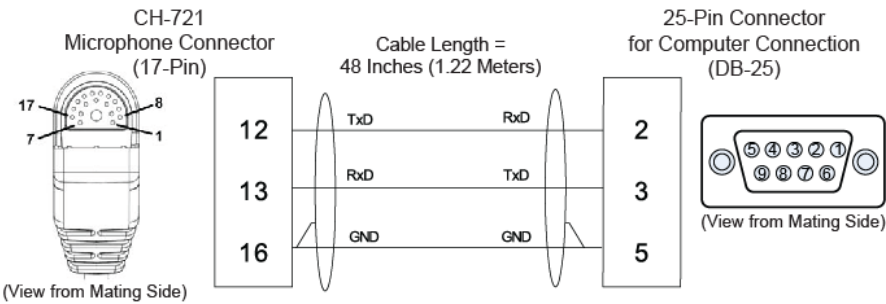
PARTS LIST

2	1760823-3	O-RING GASKET,MATERIAL:EPDM.Marco:e1000-007.	10
2	1760603-4	#4-40 Screw ,L=29.12mm,	9
1	1537068-7	Label Size: 40*50mm. White:15mm	8
1	6-1487175-8	DB9 Female, Contact: Gold Plated, Solder Type	7
		Insulation: Black	
AR	4-1537140-2	UL2464 24AWG*9C+Al/Mylar+Drain+Braid	6
		Color: Black	
2	1-1537095-8	#4-40 Thread.	5
AR	8-1487208-5	Inner Mold PE	4
AR	2-1487213-9	Copper Foil 360° Soldered.	3
AR	1-1487209-3	Overmolded PVC, Color: Black.	2
1	8-1487175-1	DB9 Male, Contact: Gold Plated, Solder Type	1
		Insulation: Black	
-1	PART NO.	DESCRIPTION	ITEM

CH-721 PROGRAMMING CABLE
CA-104861

(Made From PS-CA-104861 Rev. B)

10.3 CH-721 MIC CONNECTOR PROGRAMMING CABLE CA-103541-001



CH-721 MIC CONNECTOR PROGRAMMING CABLE
CA-103541-001

(Made From PS-CA-103541 Rev. A)

11 PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter," which is followed by a number in some cases. The revision includes all previous revisions. Refer to the Parts List for the descriptions of parts affected by these revisions.

CU23218-0001 - CH-721 Scan Model Control Head (Local):

Rev. – Initial release.

Rev. A See CB103368V1 Rev. A.

Rev. B No changes.

Rev. C See CB103368V1 Rev. B.

CU23218-0002 - CH-721 Scan Model Control Head (Remote):

Rev. – Initial release.

Rev. A See CB103368V1 Rev. A.

Rev. B See CB23224-0001 Rev. A.

Rev. C See CB23224-0001 Rev. B.

Rev. D See CB23224-0001 Rev. A

Rev. G No changes.

Rev. H See CB103368V1 Rev. B.

Rev. J See CB23224-0001 Rev. C.

Rev. K See CB23224-0001 Rev. D.

CU23218-0003 - CH-721 System Model Control Head (Local):

Rev. – Initial release.

Rev. A See CB103368V1 Rev. A.

Rev. B No changes.

Rev. C See CB103368V1 Rev. B.

CU23218-0004 - CH-721 System Model Control Head (Remote):

Rev. – Initial release.

Rev. A See CB103368V1 Rev. A.

Rev. B See CB23224-0001 Rev. A.

Rev. C See CB23224-0001 Rev. B.

Rev. D See CU23218-0002 Rev. D.

Rev. G No changes.

Rev. H See CB103368V1 Rev. B.

Rev. J See CB23224-0001 Rev. C.

Rev. K See CB23224-0001 Rev. D.

CB103368V1 - CH-721 Display/DSP Board (CMC-1290A)

- Rev. – Initial release.
- Rev. A To improve volume control operation, changed R55 on Display/DSP Board from 10K ohms to 22K ohms. Also corrected printed circuit board wiring error near DSP U9 by adding a connection to ground at the junction of C52 (-) and C53 (-). See sheet 5 of the Display/DSP Board schematic.
- Rev. B To eliminate display power supply noise in speaker at low volume settings, changed C146 and R157 and added C200 to the Display/DSP Board. C146 changed from 1000 pF to 0.47 μ F. R157 changed from 18K Ω to 9.1K Ω . C200 is 47 μ F. See sheet 10 of the Display/DSP Board schematic.
- Rev. C To replace obsolete opto-isolator, phototransistor IC, changed U15 from PS7200A to TLP179D and change associated resistor R106 from 10K to 1K ohms.

CB103369V1 - CH-721 System Keypad Board

- Rev. – Initial release.
- Rev. A To improve volume control operation, changed R55 on Display/DSP Board from 10K ohms to 22K ohms. Also corrected printed circuit board wiring error near DSP U9 by adding a connection to ground at the junction of C52 (-) and C53 (-). See sheet 5 of the Display/DSP Board schematic.
- Rev. B No changes.

CB103369V2 - CH-721 Scan Keypad Board

- Rev. – Initial release.
- Rev. B No changes.

CB23224-0001 - CH-721 Remote Interface Board

- Rev. - Initial release.
- Rev. A To improve speaker audio output, changed speaker audio connector J1. To improve rear panel connectors' reliability changed CAN connectors J2 through J4. These connectors are shown on Remote Interface Board schematic sheets 1 and 2.
- Rev. B To increase Public Address (PA) audio output level at DB-25 accessory connector pins 11 (MIC_HI) and 12 (MIC_LOW), increased C31 and C32 on the Remote Interface Board from 0.01 μ F to 0.47 μ F. See sheet 2 of the Remote Interface Board schematic.
- Rev. C To improve operation, added capacitors C54 through C68 on Remote Interface Board at DB-25 accessory connector J7. See sheet 2 of the revision C Remote Interface Board schematic.
- Rev. D To replace obsolete audio amplifier IC, changed U3 on Remote Interface Board from TDA8563AQ to TDA7391. To support this change, also changed printed circuit board, added U8, and changed several component values. See sheet 1 of the revision D Remote Interface Board schematic.

FM-013351 - CH-721 Display/DSP Board (CMC-1290A)

- Rev. – Initial release.
- Rev. A See CB103368V1 Rev. A.

Rev. B See CB103368V1 Rev. B.

Rev. C See CB103368V1 Rev. C.

MA-013352 - CH-721 Remote Interface Board Kit

Rev. – Initial release.

Rev. A See CB23224-0001 Rev. A.

Rev. B See CB23224-0001 Rev. B.

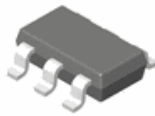
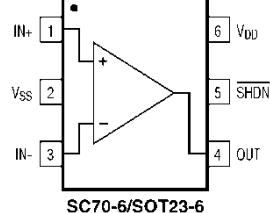
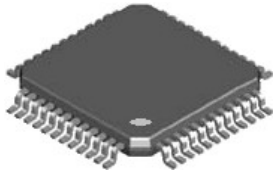
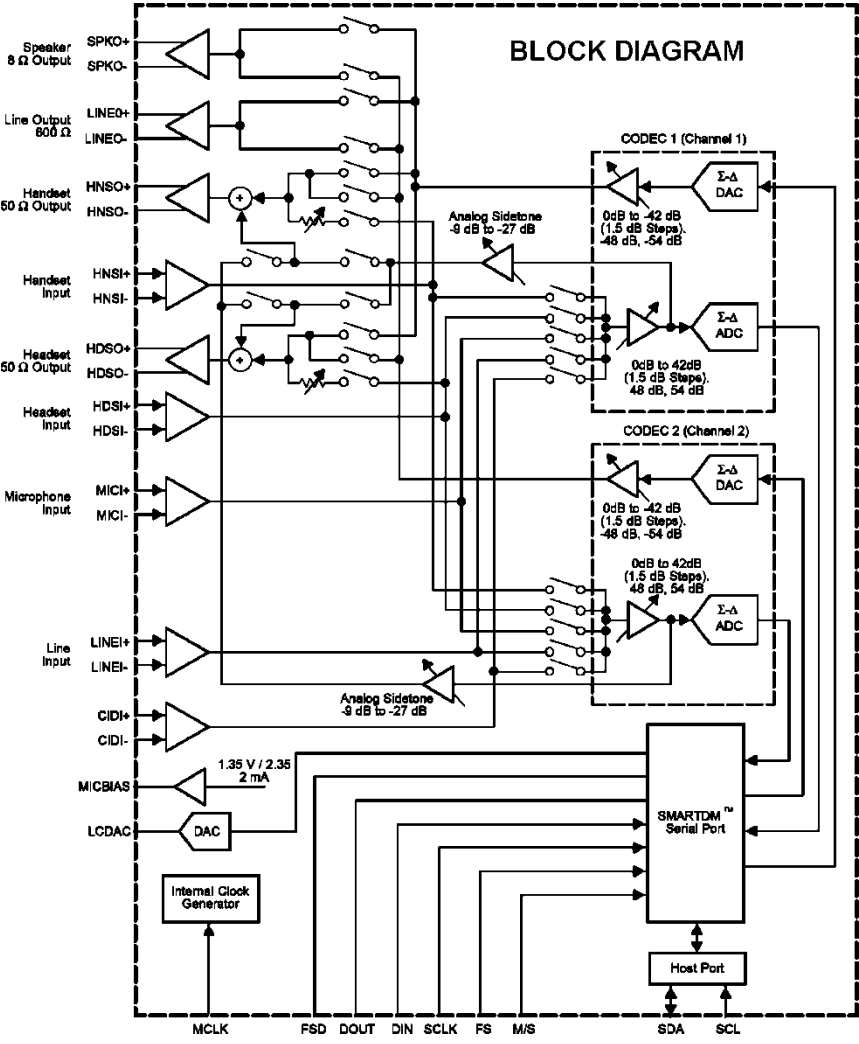
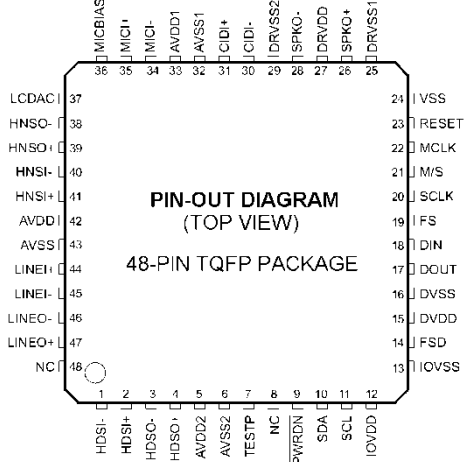
Rev. E No changes.

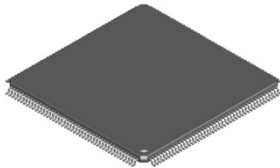
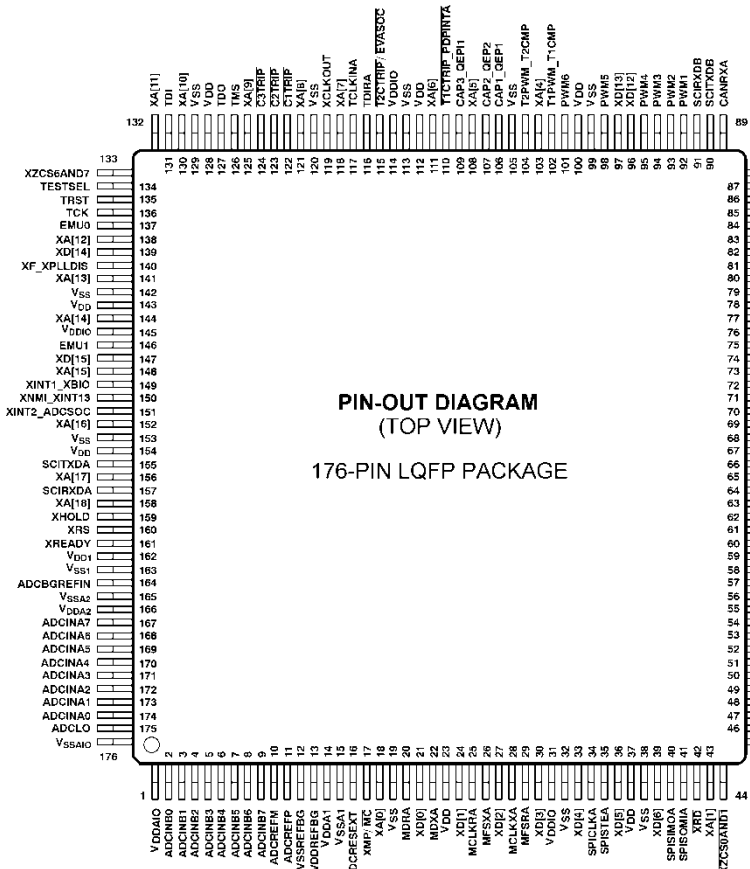
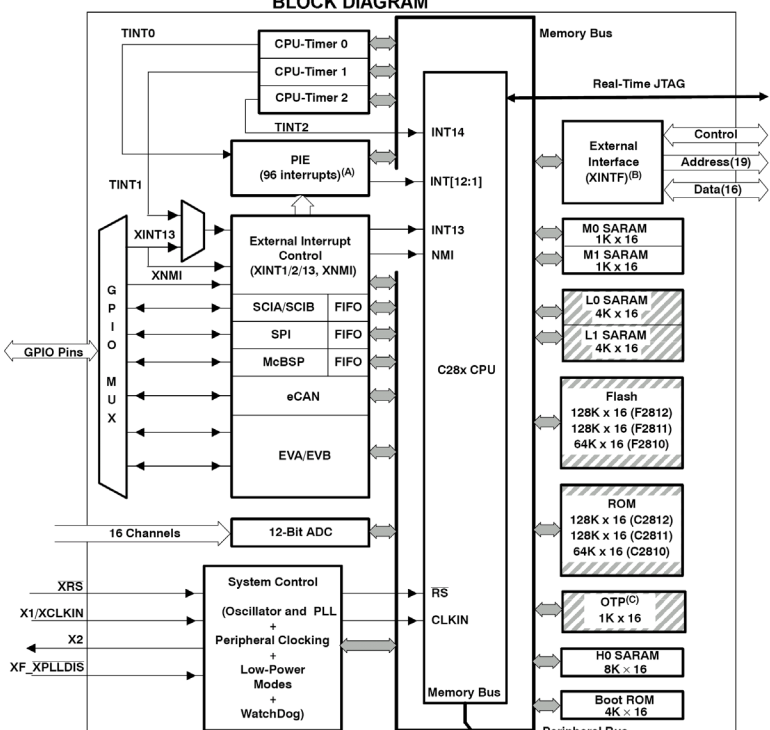
Rev. F Revised drawings.

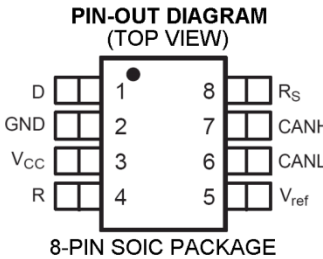
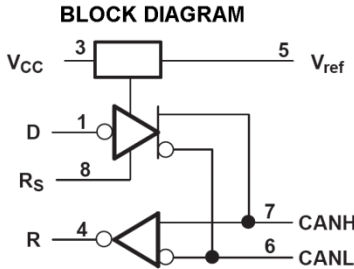
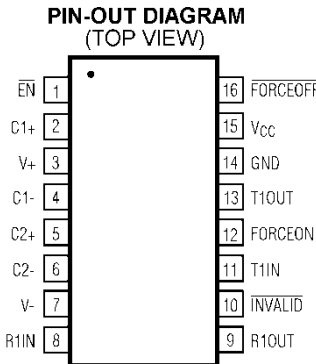
Rev. G Improved kit to include the new audio amplifier clip 14007-0107-01 to the CH721 Remote Mount PWB Interface Assembly Kit (MA-013352) and the CH721 Remote Mount Clip Kit (MA-013358). Refer to Table 8-1, Kitted Parts Available for CH-721 Scan and System Model Control Heads.

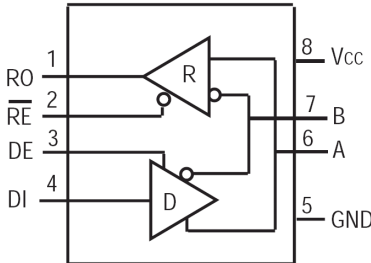
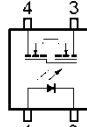
12 IC DATA

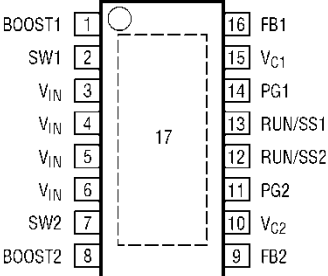
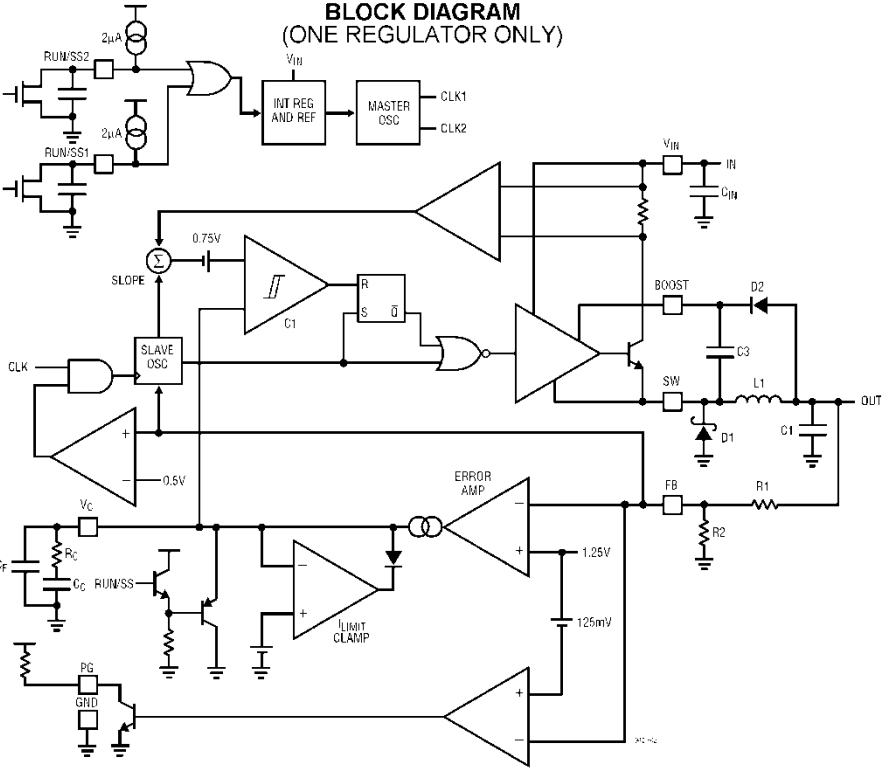
12.1 INTEGRATED CIRCUITS ON DISPLAY/DSP BOARD

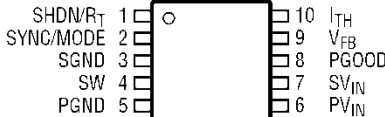
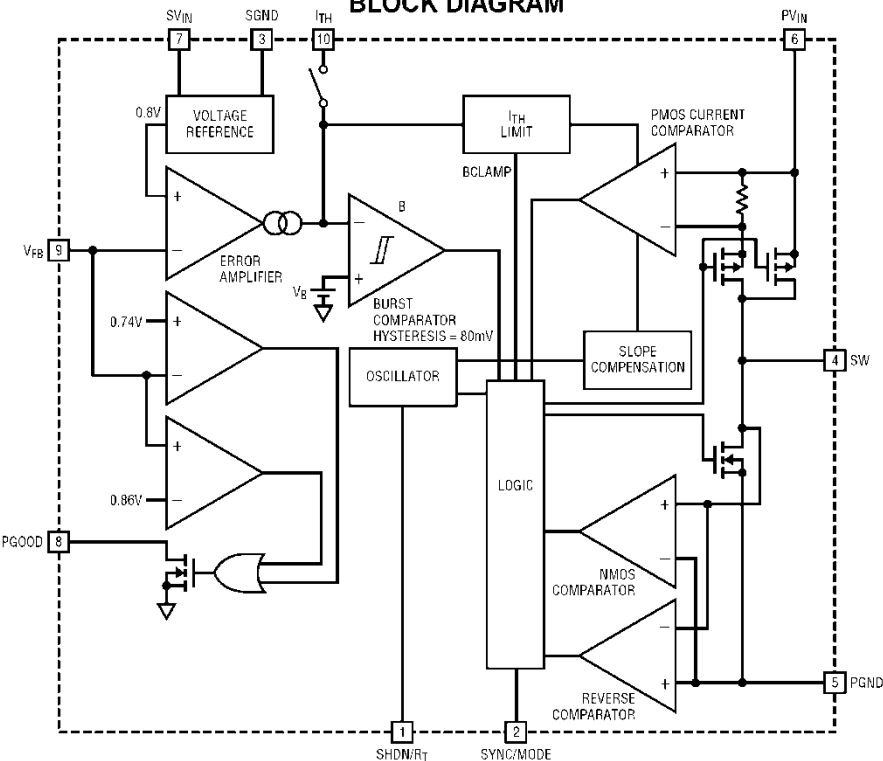
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U2	Rail-to-Rail Low-Power Op Amp; similar to Maxim MAX4245AUT-T 	PIN-OUT DIAGRAM (TOP VIEW)  SC70-6/SOT23-6
U7	16-Bit Dual-Channel Voice-Band CODEC; similar to Texas Instruments TLV320AIC20KIPFBR 	BLOCK DIAGRAM  PIN-OUT DIAGRAM (TOP VIEW) 48-PIN TQFP PACKAGE 

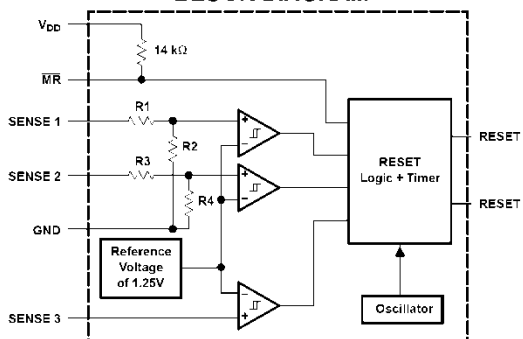
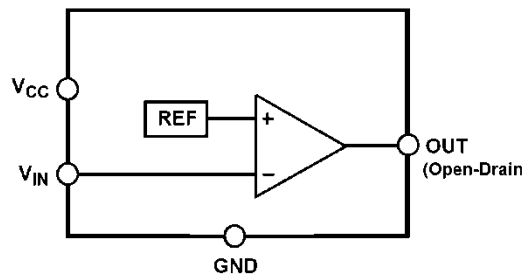
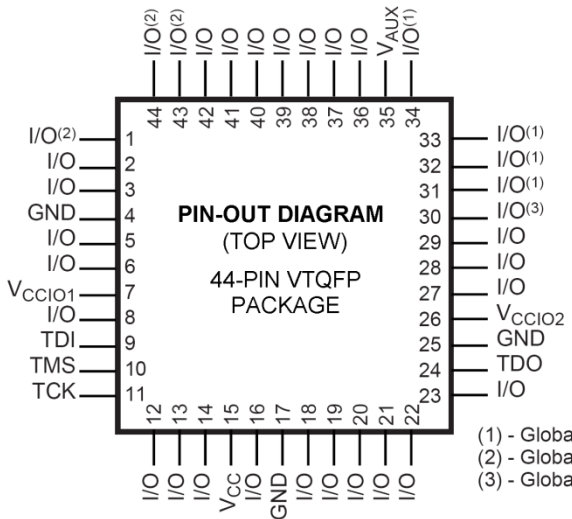
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U9	Digital Signal Processor (DSP) with 32-Bit CPU; similar to Texas Instruments TMS320F2812PGFA 	PIN-OUT DIAGRAM (TOP VIEW) 176-PIN LQFP PACKAGE 
BLOCK DIAGRAM 		

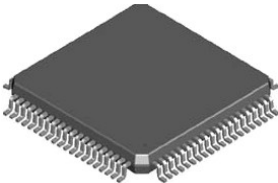
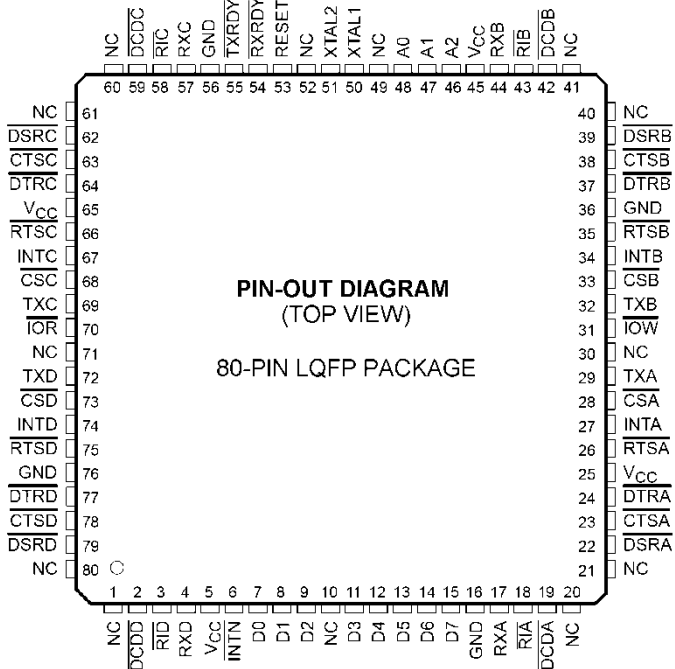
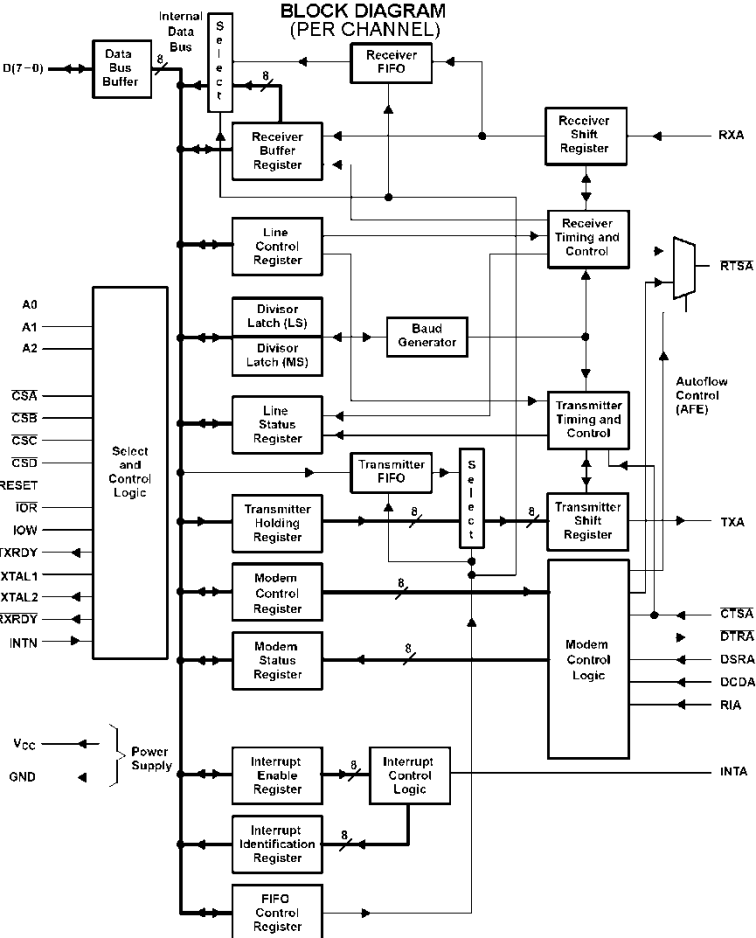
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA																																									
U10	8K Byte EEPROM with Serial Peripheral Interface (SPI); similar to Microchip 25LC080AT-I/STG																																										
U11	CAN Transceiver; similar to Texas Instruments SN65HVD230DR	PIN-OUT DIAGRAM (TOP VIEW)  BLOCK DIAGRAM  DRIVER FUNCTION TABLE <table><tr><th rowspan="2">INPUT D</th><th rowspan="2">RS</th><th colspan="2">OUTPUTS</th><th rowspan="2">BUS STATE</th></tr><tr><th>CANH</th><th>CANL</th></tr><tr><td>L</td><td rowspan="2">V(RS) < 1.2 V</td><td>H</td><td>L</td><td>Dominant</td></tr><tr><td>H</td><td>Z</td><td>Z</td><td>Recessive</td></tr><tr><td>Open</td><td>X</td><td>Z</td><td>Z</td><td>Recessive</td></tr><tr><td>X</td><td>V(RS) > 0.75 VCC</td><td>Z</td><td>Z</td><td>Recessive</td></tr></table> H = high level; L = low level; X = irrelevant; ? = indeterminate; Z = high impedance RECEIVER FUNCTION TABLE <table><tr><th>DIFFERENTIAL INPUTS</th><th>RS</th><th>OUTPUT R</th></tr><tr><td>VID ≥ 0.9 V</td><td>X</td><td>L</td></tr><tr><td>0.5 V < VID < 0.9 V</td><td>X</td><td>?</td></tr><tr><td>VID ≤ 0.5 V</td><td>X</td><td>H</td></tr><tr><td>Open</td><td>X</td><td>H</td></tr></table> H = high level; L = low level; X = irrelevant; ? = indeterminate	INPUT D	RS	OUTPUTS		BUS STATE	CANH	CANL	L	V(RS) < 1.2 V	H	L	Dominant	H	Z	Z	Recessive	Open	X	Z	Z	Recessive	X	V(RS) > 0.75 VCC	Z	Z	Recessive	DIFFERENTIAL INPUTS	RS	OUTPUT R	VID ≥ 0.9 V	X	L	0.5 V < VID < 0.9 V	X	?	VID ≤ 0.5 V	X	H	Open	X	H
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0.5 V < VID < 0.9 V	X	?																																									
VID ≤ 0.5 V	X	H																																									
Open	X	H																																									
U12	TIA/EIA/RS-232 Transceiver with Auto-Shutdown; similar to Maxim MAX3221EEAE+T	PIN-OUT DIAGRAM (TOP VIEW)  16-PIN SSOP PACKAGE																																									

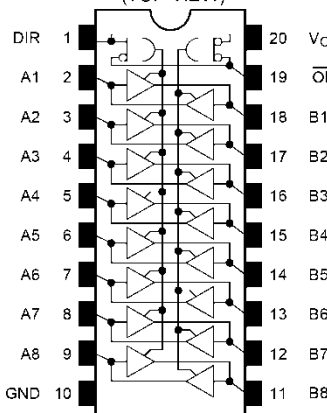
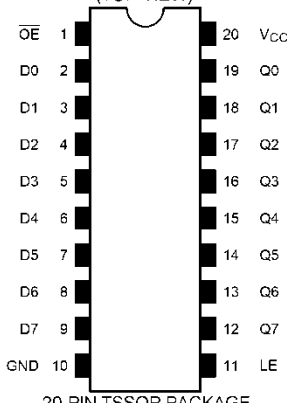
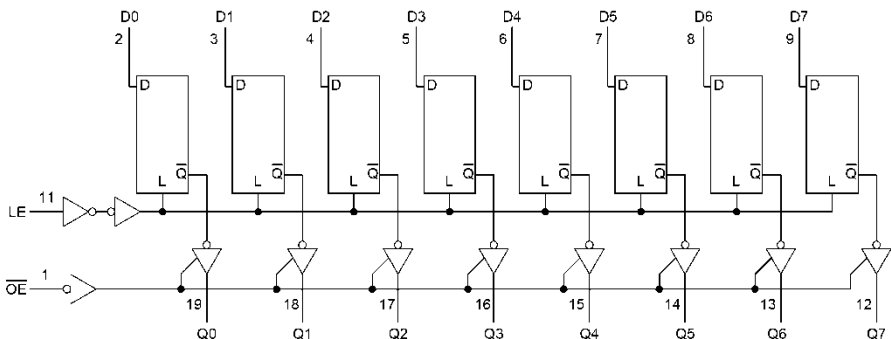
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA																																																										
U13	TIA/EIA/RS-485/ RS-422 Half-Duplex Transceiver; similar to Sipex SP3072EEN-L/TR 	PIN-OUT DIAGRAM (TOP VIEW)  8-PIN NSOIC PACKAGE <table><caption>TRANSMITTING FUNCTION TABLE</caption><thead><tr><th colspan="3">Inputs</th><th colspan="2">Outputs</th></tr><tr><th>RE</th><th>DE</th><th>DI</th><th>B/Z</th><th>A/Y</th></tr></thead><tbody><tr><td>X</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>X</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>X</td><td colspan="2">High-Z</td></tr><tr><td>1</td><td>0</td><td>X</td><td colspan="2">Shutdown</td></tr></tbody></table> <table><caption>RECEIVING FUNCTION TABLE</caption><thead><tr><th colspan="3">Inputs</th><th>Output</th></tr><tr><th>RE</th><th>DE</th><th>A, B</th><th>RO</th></tr></thead><tbody><tr><td>0</td><td>X</td><td>$\geq -50\text{mV}$</td><td>1</td></tr><tr><td>0</td><td>X</td><td>$\leq -200\text{mV}$</td><td>0</td></tr><tr><td>0</td><td>X</td><td>Open/shorted</td><td>1</td></tr><tr><td>1</td><td>1</td><td>X</td><td>High-Z</td></tr><tr><td>1</td><td>0</td><td>X</td><td>Shutdown</td></tr></tbody></table>	Inputs			Outputs		RE	DE	DI	B/Z	A/Y	X	1	1	0	1	X	1	0	1	0	0	0	X	High-Z		1	0	X	Shutdown		Inputs			Output	RE	DE	A, B	RO	0	X	$\geq -50\text{mV}$	1	0	X	$\leq -200\text{mV}$	0	0	X	Open/shorted	1	1	1	X	High-Z	1	0	X	Shutdown
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1	1	X	High-Z																																																									
1	0	X	Shutdown																																																									
U14 & U16	Opto-Isolator with High-Voltage Darlington Output Transistor; similar to NEC PS2702-1-F3-A 	PIN-OUT DIAGRAM (TOP VIEW)  4-PIN SOP PACKAGE 1. Anode 2. Cathode 3. Emitter 4. Collector																																																										
U15	Opto-Isolator with MOSFET Output Transistor; similar to Toshiba TLP179D 	PIN-OUT DIAGRAM (TOP VIEW)  4-PIN SOP PACKAGE 1. LED Anode 2. LED Cathode 3. MOS FET 4. MOS FET																																																										

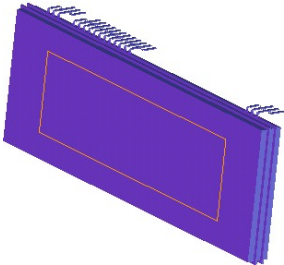
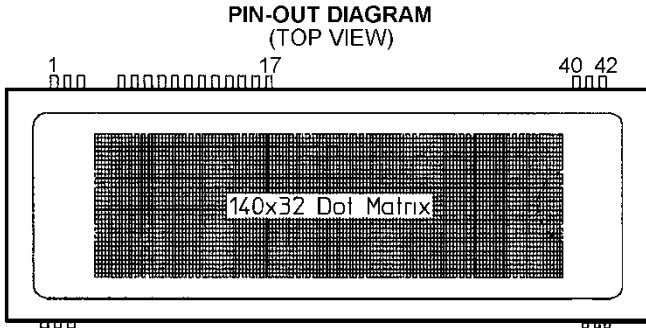
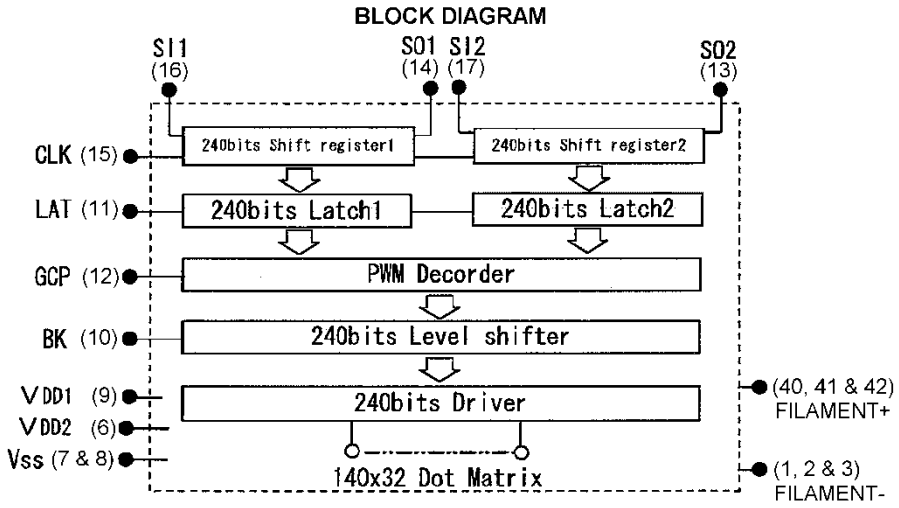
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U17	Dual Step-Down Switching Voltage Regulator; similar to Linear Technology LT1940EFE 	PIN-OUT DIAGRAM (TOP VIEW)  FE PACKAGE 16-LEAD PLASTIC TSSOP EXPOSED PAD (PIN 17) IS GND BLOCK DIAGRAM (ONE REGULATOR ONLY) 

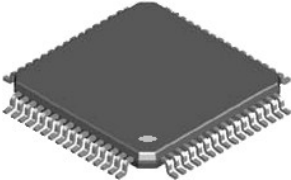
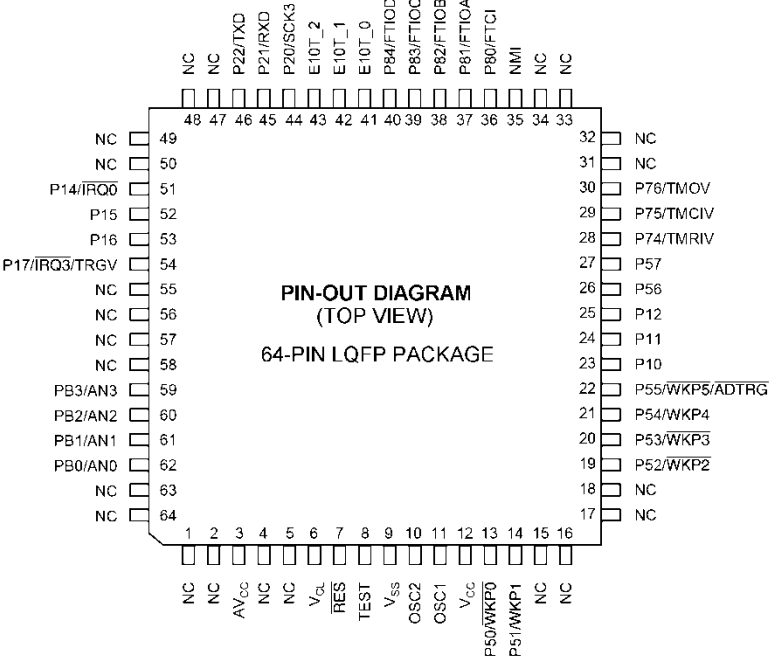
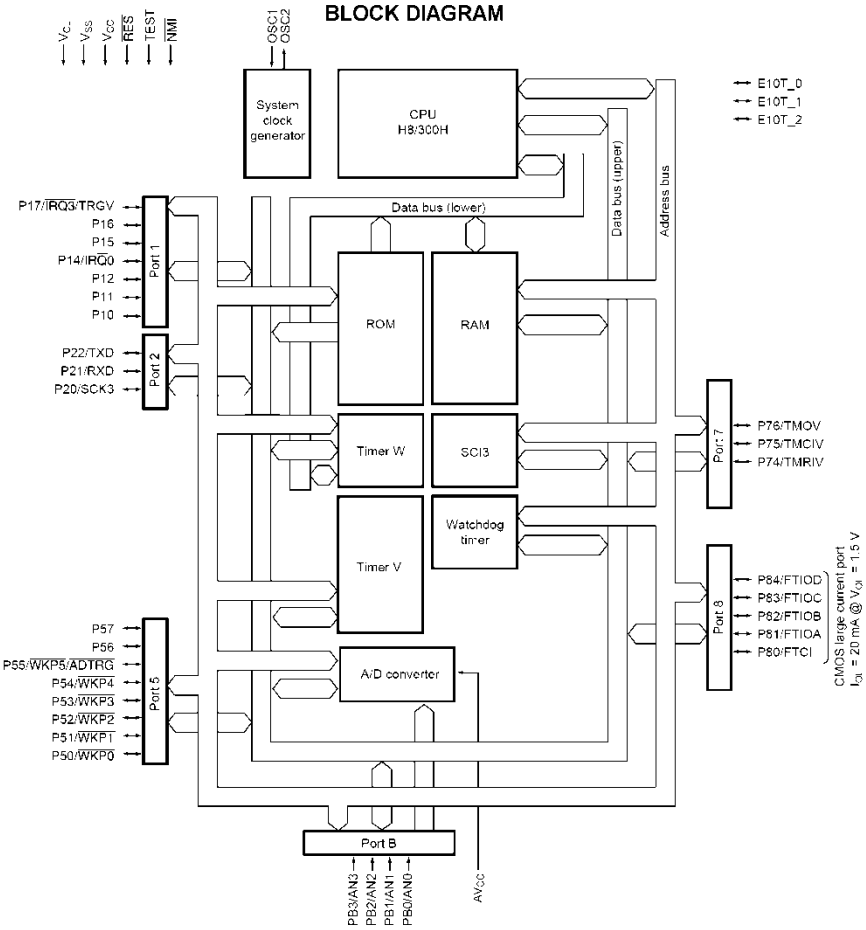
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U18	Synchronous Step-Down DC/DC Converter; similar to Linear Technology LTC3411EMS 	PIN-OUT DIAGRAM (TOP VIEW)  MS PACKAGE 10-LEAD PLASTIC MSOP BLOCK DIAGRAM 

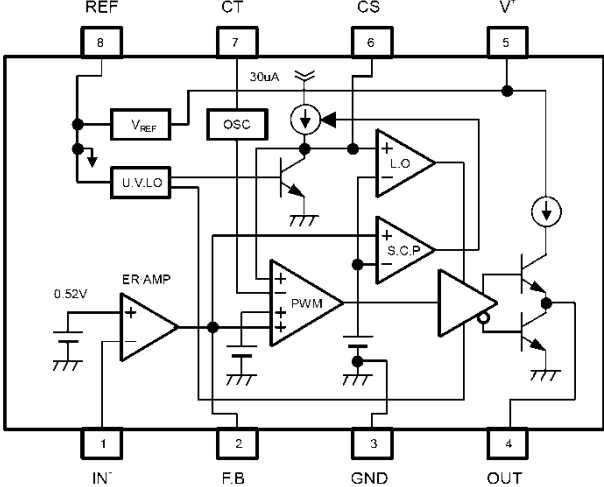
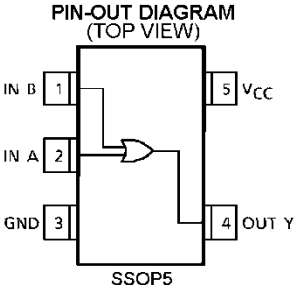
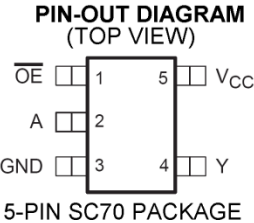
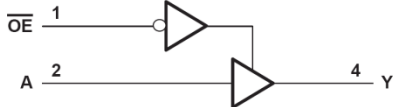
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA																																																												
U19	Microprocessor Supervisor; similar to Texas Instruments TPS3307DGNR 	PIN-OUT DIAGRAM (TOP VIEW) SENSE1 1 8 V_{DD} SENSE2 2 7 MR SENSE3 3 6 RESET GND 4 5 RESET 8-PIN MSOP PACKAGE WITH POWERPAD BLOCK DIAGRAM  TRUTH DIAGRAM <table><thead><tr><th>MR</th><th>SENSE1 > V_{IT1}</th><th>SENSE2 > V_{IT2}</th><th>SENSE3 > V_{IT3}</th><th>RESET</th><th>RESET</th></tr></thead><tbody><tr><td>L</td><td>X⁽¹⁾</td><td>X⁽¹⁾</td><td>X</td><td>L</td><td>H</td></tr><tr><td>H</td><td>0</td><td>0</td><td>0</td><td>L</td><td>H</td></tr><tr><td>H</td><td>0</td><td>0</td><td>1</td><td>L</td><td>H</td></tr><tr><td>H</td><td>0</td><td>1</td><td>0</td><td>L</td><td>H</td></tr><tr><td>H</td><td>0</td><td>1</td><td>1</td><td>L</td><td>H</td></tr><tr><td>H</td><td>1</td><td>0</td><td>0</td><td>L</td><td>H</td></tr><tr><td>H</td><td>1</td><td>0</td><td>1</td><td>L</td><td>H</td></tr><tr><td>H</td><td>1</td><td>1</td><td>0</td><td>L</td><td>H</td></tr><tr><td>H</td><td>1</td><td>1</td><td>1</td><td>H</td><td>L</td></tr></tbody></table> (1) X = Don't care	MR	SENSE1 > V _{IT1}	SENSE2 > V _{IT2}	SENSE3 > V _{IT3}	RESET	RESET	L	X ⁽¹⁾	X ⁽¹⁾	X	L	H	H	0	0	0	L	H	H	0	0	1	L	H	H	0	1	0	L	H	H	0	1	1	L	H	H	1	0	0	L	H	H	1	0	1	L	H	H	1	1	0	L	H	H	1	1	1	H	L
MR	SENSE1 > V _{IT1}	SENSE2 > V _{IT2}	SENSE3 > V _{IT3}	RESET	RESET																																																									
L	X ⁽¹⁾	X ⁽¹⁾	X	L	H																																																									
H	0	0	0	L	H																																																									
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H	1	1	0	L	H																																																									
H	1	1	1	H	L																																																									
U21	Voltage Comparator with 0.6 V Reference; similar to Analog Devices ADCMP350YKS 	PIN-OUT DIAGRAM (TOP VIEW) V_{IN} 1 4 V_{CC} GND 2 3 OUT 4-PIN SC70 PACKAGE BLOCK DIAGRAM 																																																												
U22	64-Macrocell CMOS Programmable Logic Device (CPLD); similar to Xilinx XC2C64A-7VQG44I (Factory Programmed) 	PIN-OUT DIAGRAM (TOP VIEW) 44-PIN VTQFP PACKAGE  (1) - Global Output Enable (2) - Global Clock (3) - Global Set/Reset																																																												

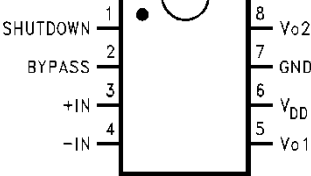
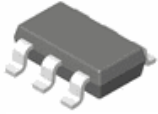
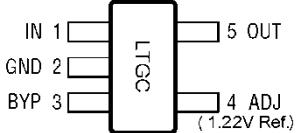
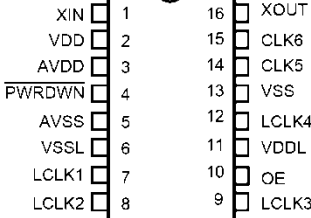
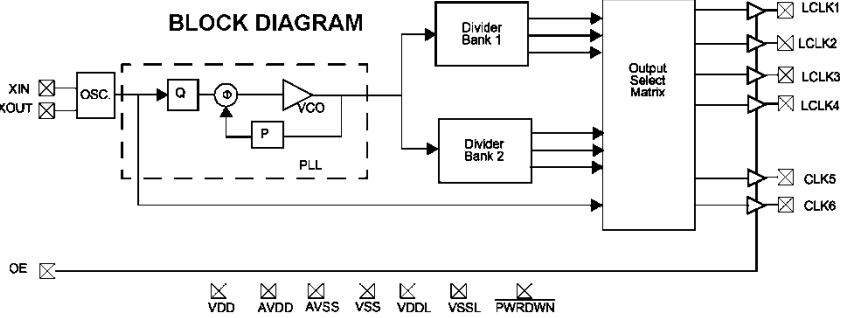
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U23	Quad Asynchronous Communication Element (ACE) with 16-Byte FIFOs; similar to Texas Instruments TL16C554AIPNR 	PIN-OUT DIAGRAM (TOP VIEW) 80-PIN LQFP PACKAGE  BLOCK DIAGRAM (PER CHANNEL) 

ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA																								
U24	3-State Octal Bus Transceiver with 5 V Tolerant Inputs and Outputs; similar to Toshiba TC74LCX245FT 	PIN-OUT DIAGRAM (TOP VIEW)  TRUTH TABLE <table><tr><th colspan="2">Inputs</th><th rowspan="2">Outputs</th><th colspan="2">Function</th></tr><tr><th>OE</th><th>DIR</th><th>A-Bus</th><th>B-Bus</th></tr><tr><td>L</td><td>L</td><td>A = B</td><td>Output</td><td>Input</td></tr><tr><td>L</td><td>H</td><td>B = A</td><td>Input</td><td>Output</td></tr><tr><td>H</td><td>X</td><td>Z</td><td colspan="2">Z</td></tr></table> X: Don't care Z: High impedance	Inputs		Outputs	Function		OE	DIR	A-Bus	B-Bus	L	L	A = B	Output	Input	L	H	B = A	Input	Output	H	X	Z	Z	
Inputs		Outputs	Function																							
OE	DIR		A-Bus	B-Bus																						
L	L	A = B	Output	Input																						
L	H	B = A	Input	Output																						
H	X	Z	Z																							
U25	Octal Data Latch; similar to Toshiba TC74LCX573FT 	PIN-OUT DIAGRAM (TOP VIEW)  TRUTH TABLE <table><tr><th colspan="3">Inputs</th><th rowspan="2">Outputs</th></tr><tr><th>OE</th><th>LE</th><th>D</th></tr><tr><td>H</td><td>X</td><td>X</td><td>Z</td></tr><tr><td>L</td><td>L</td><td>X</td><td>Qn</td></tr><tr><td>L</td><td>H</td><td>L</td><td>L</td></tr><tr><td>L</td><td>H</td><td>H</td><td>H</td></tr></table> X: Don't care Z: High impedance Qn: Q outputs are latched at the time when the LE input is taken to a low logic level. LOGIC DIAGRAM 	Inputs			Outputs	OE	LE	D	H	X	X	Z	L	L	X	Qn	L	H	L	L	L	H	H	H	
Inputs			Outputs																							
OE	LE	D																								
H	X	X	Z																							
L	L	X	Qn																							
L	H	L	L																							
L	H	H	H																							

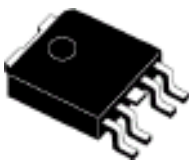
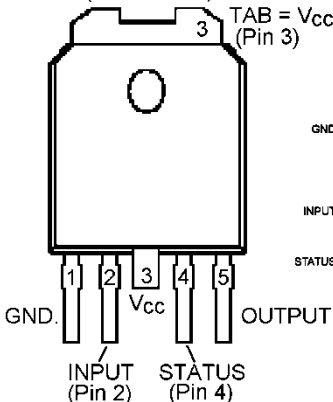
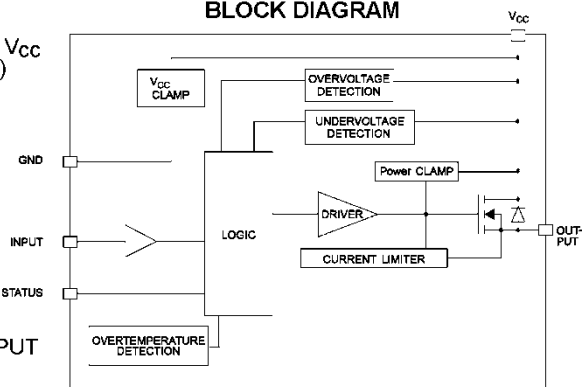
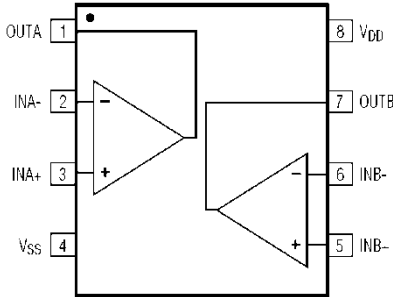
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U26	140 x 32 Dot-Matrix Vacuum-Fluorescent Display (VFD); similar to Noritake 7000-Series NM14032AC 	PIN-OUT DIAGRAM (TOP VIEW)  BLOCK DIAGRAM 

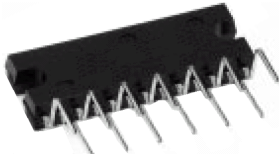
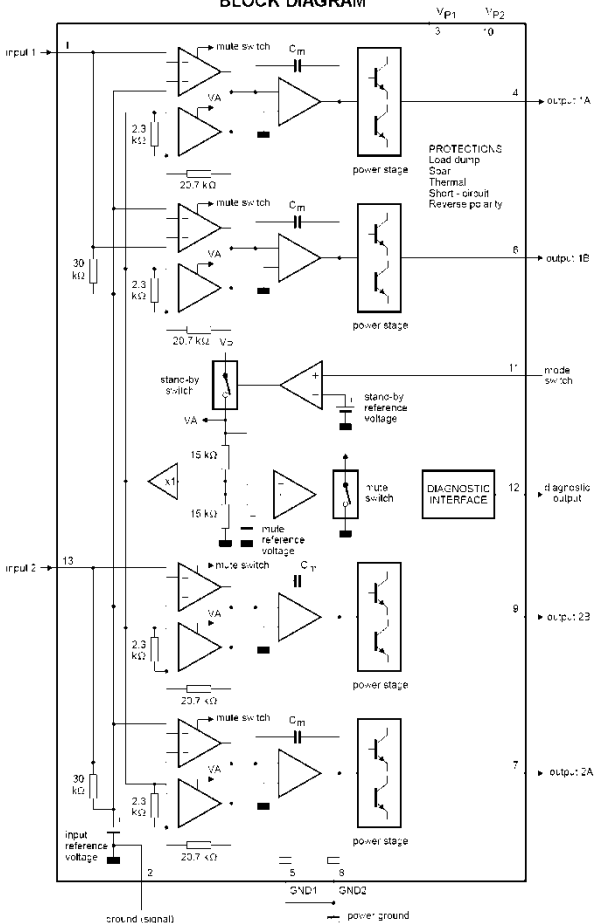
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U27	16-Bit Microcomputer with 16 KB Flash ROM; similar to Hitachi/Renesas HD64F3672FP (Factory Programmed) 	PIN-OUT DIAGRAM (TOP VIEW) 64-PIN LQFP PACKAGE  BLOCK DIAGRAM  CMOS large current port $I_{OL} = 20\text{ mA @ }V_{OL} = 1.5\text{ V}$

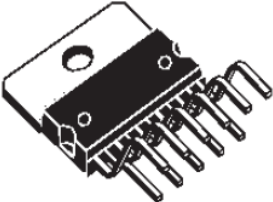
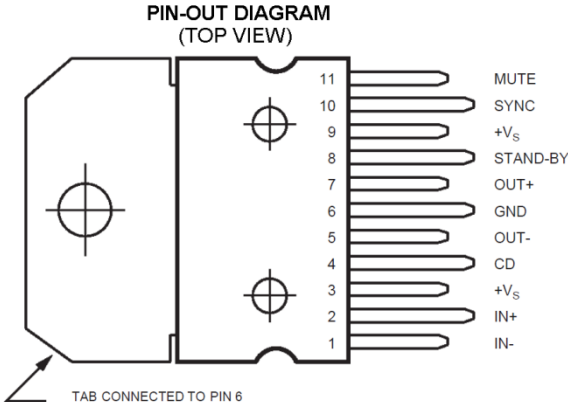
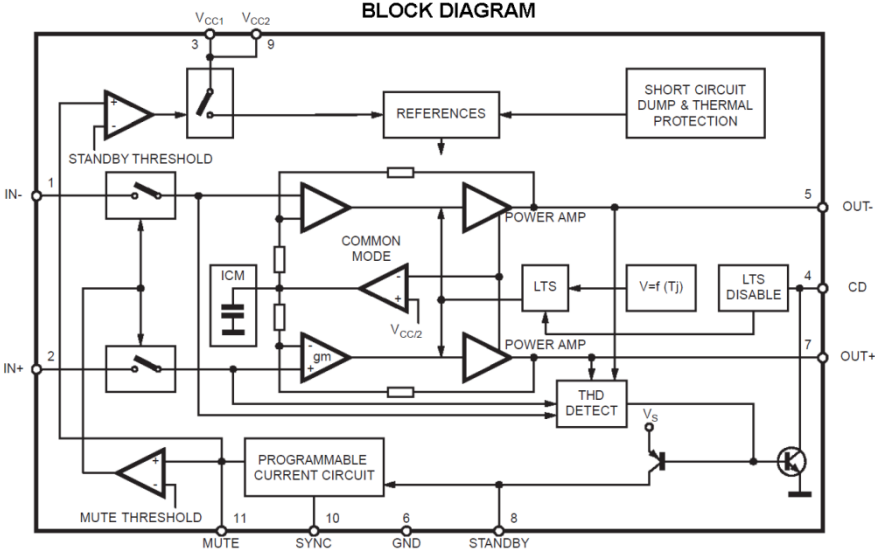
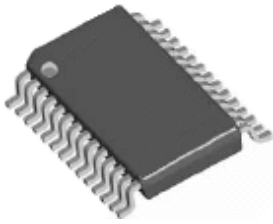
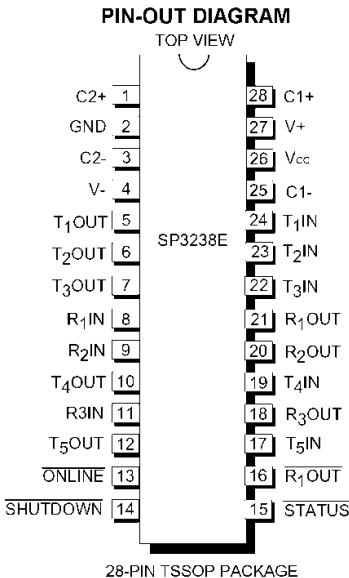
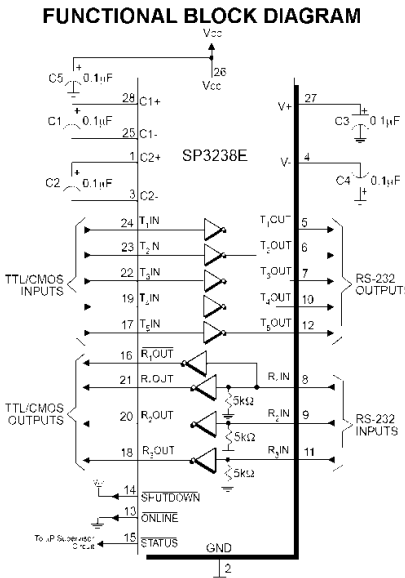
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA															
U28	Switching Voltage Regulator Controller; similar to New JRC Ltd. NJM2377M 	PIN-OUT DIAGRAM (TOP VIEW)  8-PIN SSOP PACKAGE															
U29 & U36	Single 2-Input OR Gate; similar to Toshiba TC7SET32FU 	PIN-OUT DIAGRAM (TOP VIEW)  SSOP5 TRUTH TABLE <table><tr><th>A</th><th>B</th><th>Y</th></tr><tr><td>H</td><td>H</td><td>H</td></tr><tr><td>L</td><td>H</td><td>H</td></tr><tr><td>H</td><td>L</td><td>H</td></tr><tr><td>L</td><td>L</td><td>L</td></tr></table>	A	B	Y	H	H	H	L	H	H	H	L	H	L	L	L
A	B	Y															
H	H	H															
L	H	H															
H	L	H															
L	L	L															
U30	Single 3-State Bus Buffer; similar to Texas Instruments SN74LVC1G125DCK 	PIN-OUT DIAGRAM (TOP VIEW)  5-PIN SC70 PACKAGE TRUTH TABLE <table><tr><th colspan="2">INPUTS</th><th>OUTPUT</th></tr><tr><th>OE</th><th>A</th><th>Y</th></tr><tr><td>L</td><td>H</td><td>H</td></tr><tr><td>L</td><td>L</td><td>L</td></tr><tr><td>H</td><td>X</td><td>Z</td></tr></table> LOGIC DIAGRAM 	INPUTS		OUTPUT	OE	A	Y	L	H	H	L	L	L	H	X	Z
INPUTS		OUTPUT															
OE	A	Y															
L	H	H															
L	L	L															
H	X	Z															

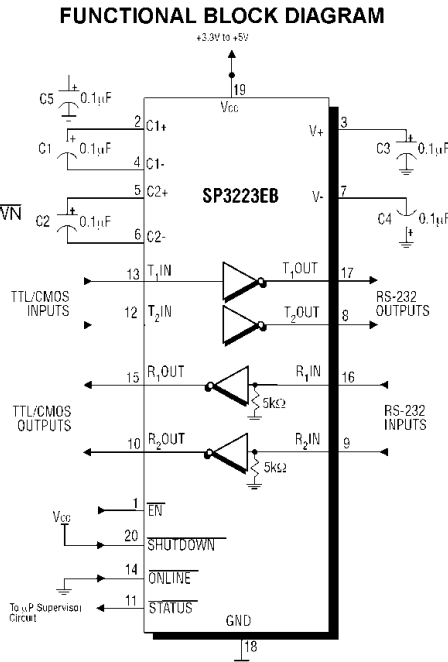
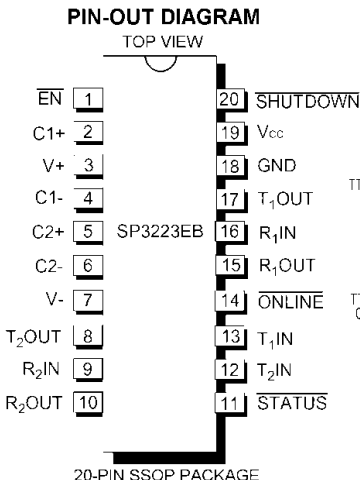
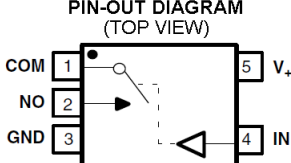
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U31	3-Watt Audio Power Amplifier; similar to National Semiconductor LM4871MM 	PIN-OUT DIAGRAM (TOP VIEW)  8-PIN MSOP PACKAGE
U35	5 V 100-mA Low Drop-Out (LDO) Voltage Regulator; similar to Linear Technology LT1761ES5-BYP 	PIN-OUT DIAGRAM (TOP VIEW)  5-PIN SOT-23 PACKAGE
U36	Same as U29 shown on page 108.	
U37	Programmable Clock Generator; similar to Cypress CY22050ZXI (Factory Programmed) 	PIN-OUT DIAGRAM (TOP VIEW)  8-PIN TSSOP PACKAGE BLOCK DIAGRAM 

12.2 INTEGRATED CIRCUITS ON REMOTE INTERFACE BOARD

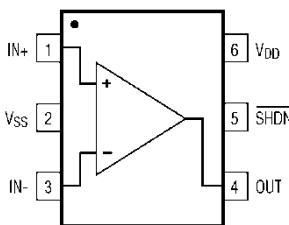
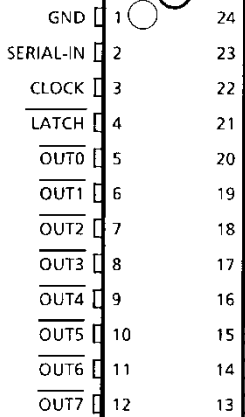
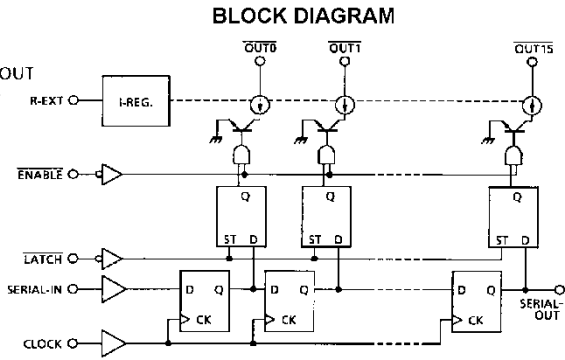
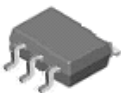
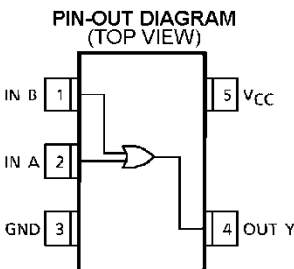
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA																																							
U1	High-Side MOSFET Driver; similar to STMicroelectronics VN751PT 	PIN-OUT DIAGRAM (TOP VIEW)  BLOCK DIAGRAM  TRUTH TABLE <table><tr><th>Conditions</th><th>Input</th><th>Output</th><th>Status</th></tr><tr><td rowspan="2">Normal operation</td><td>L</td><td>L</td><td>H</td></tr><tr><td>H</td><td>H</td><td>H</td></tr><tr><td rowspan="2">Current limitation</td><td>L</td><td>L</td><td>H</td></tr><tr><td>H</td><td>X</td><td>($T_J < T_{TSD}$) H ($T_J > T_{TSD}$) L</td></tr><tr><td rowspan="2">Overtemperature</td><td>L</td><td>L</td><td>H</td></tr><tr><td>H</td><td>L</td><td>L</td></tr><tr><td rowspan="2">Undervoltage</td><td>L</td><td>L</td><td>X</td></tr><tr><td>H</td><td>L</td><td>X</td></tr><tr><td rowspan="2">Overvoltage</td><td>L</td><td>L</td><td>H</td></tr><tr><td>H</td><td>L</td><td>H</td></tr></table> T_J = Junction operating temperature T_{TSD} = Shut-down temperature	Conditions	Input	Output	Status	Normal operation	L	L	H	H	H	H	Current limitation	L	L	H	H	X	($T_J < T_{TSD}$) H ($T_J > T_{TSD}$) L	Overtemperature	L	L	H	H	L	L	Undervoltage	L	L	X	H	L	X	Overvoltage	L	L	H	H	L	H
Conditions	Input	Output	Status																																						
Normal operation	L	L	H																																						
	H	H	H																																						
Current limitation	L	L	H																																						
	H	X	($T_J < T_{TSD}$) H ($T_J > T_{TSD}$) L																																						
Overtemperature	L	L	H																																						
	H	L	L																																						
Undervoltage	L	L	X																																						
	H	L	X																																						
Overvoltage	L	L	H																																						
	H	L	H																																						
U2	Rail-to-Rail Low-Power Op Amp; similar to Maxim MAX4246AKA+T 	PIN-OUT DIAGRAM (TOP VIEW)  SOT23-8/μMAX/SO																																							

ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U3 (Rev. C and Earlier Remote Interface Board)	2-Channel 40-Watt Audio Amplifier; similar to Philips TDA8563AQ  Used on Revision C and Earlier Remote Interface Board	PIN-OUT DIAGRAM IN 1 1 GND(S) 2 V_{P1} 3 OUT 1A 4 GND1 5 OUT 1B 6 OUT 2A 7 GND2 8 OUT 2B 9 V_{P2} 10 MODE 11 V_{DIAG} 12 IN 2 13 FRONT VIEW 13-PIN SIL PACKAGE (SOT141-6 / DBS13P) 1 2 3 4 5 6 7 8 9 10 11 12 13 BLOCK DIAGRAM 

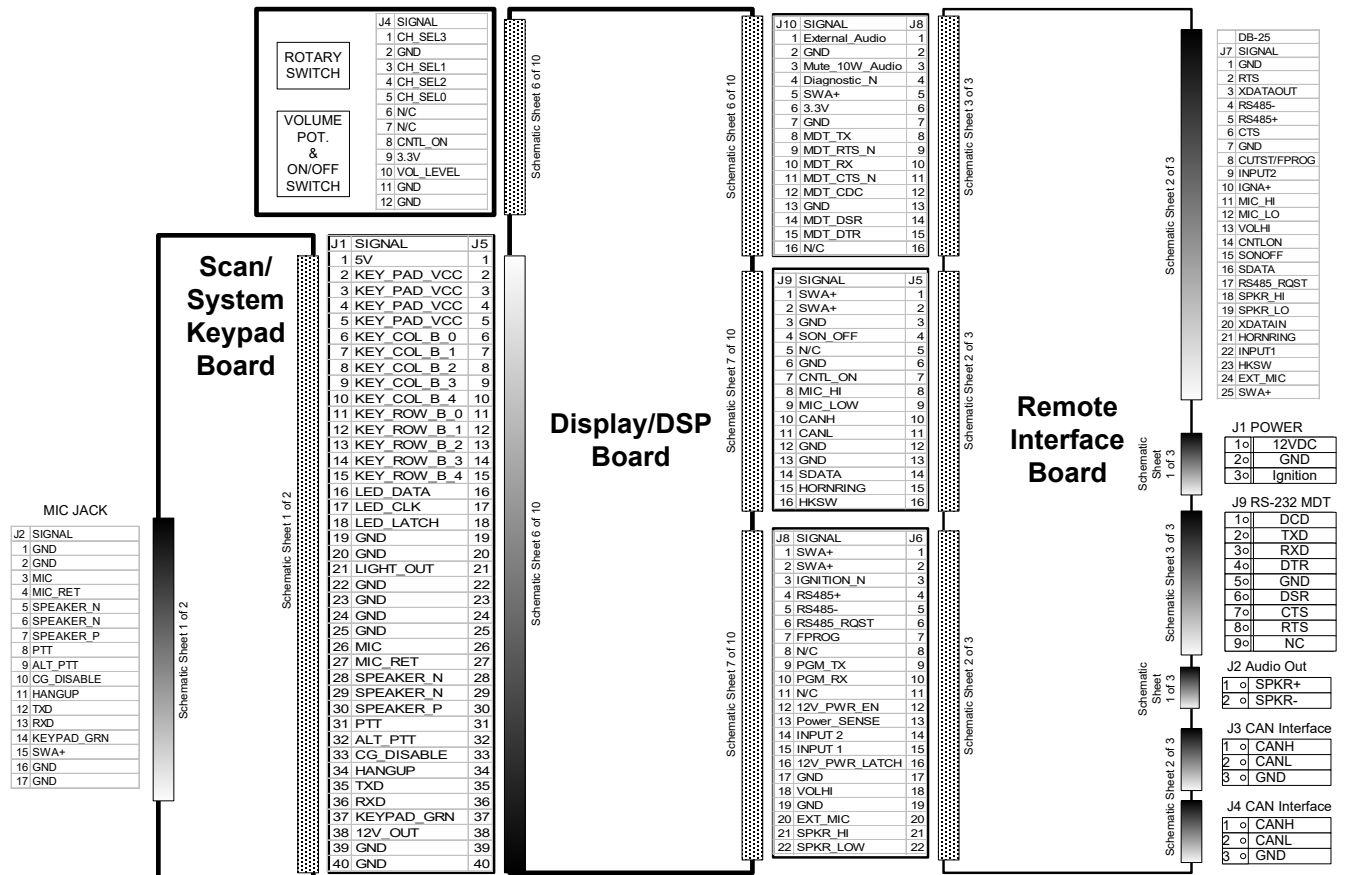
ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA
U3 (Rev. D and Later Remote Interface Board)	35-Watt Bridged Audio Amplifier; similar to STMicroelectronics TDA7391  Used on Revision D and Later Remote Interface Board	PIN-OUT DIAGRAM (TOP VIEW)  BLOCK DIAGRAM 
U6	TIA/EIA/RS-232 Transceiver; similar to Sipex SP3238EEA-L 	PIN-OUT DIAGRAM TOP VIEW  28-PIN TSSOP PACKAGE FUNCTIONAL BLOCK DIAGRAM 

ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA						
U7	TIA/EIA/RS-232 Transceiver; similar to Sipex SP3223EBEA-L 	FUNCTIONAL BLOCK DIAGRAM  PIN-OUT DIAGRAM TOP VIEW 						
U8 (Rev. D and Later Remote Interface Board)	SPST Analog Switch; similar to Texas Instruments TS5A4594DBV 	PIN-OUT DIAGRAM (TOP VIEW)  TRUTH TABLE <table><tr><th>IN</th><th>NO TO COM, COM TO NO</th></tr><tr><td>L</td><td>OFF</td></tr><tr><td>H</td><td>ON</td></tr></table>	IN	NO TO COM, COM TO NO	L	OFF	H	ON
IN	NO TO COM, COM TO NO							
L	OFF							
H	ON							

12.3 INTEGRATED CIRCUITS ON KEYPAD BOARDS

ITEM	DESCRIPTION	PIN-OUT DIAGRAMS AND ASSOCIATED DATA																																				
U1	Rail-to-Rail Low-Power Op Amp; similar to Maxim MAX4245AUT-T 	PIN-OUT DIAGRAM (TOP VIEW)  SC70-6/SOT23-6																																				
U2 & U3 & U4	16-Bit Shift Register/Latch with Constant-Current Output Drivers; similar to Toshiba TB62706BFG 	PIN-OUT DIAGRAM (TOP VIEW)  SSOP24 BLOCK DIAGRAM  TRUTH TABLE <table><tr><th>CLOCK</th><th>LATCH</th><th>ENABLE</th><th>SERIAL- IN</th><th>OUT0 ... OUT7 ... OUT15</th><th>SERIAL- OUT</th></tr><tr><td>UP</td><td>H</td><td>L</td><td>D_n</td><td>D_n ... D_{n-7} ... D_{n-15}</td><td>D_{n-15}</td></tr><tr><td>UP</td><td>L</td><td>L</td><td>D_{n+1}</td><td>No change</td><td>D_{n-14}</td></tr><tr><td>UP</td><td>H</td><td>L</td><td>D_{n+2}</td><td>D_{n+2} ... D_{n-5} ... D_{n-13}</td><td>D_{n-13}</td></tr><tr><td>DOWN</td><td>X</td><td>L</td><td>D_{n+3}</td><td>D_{n+2} ... D_{n-5} ... D_{n-13}</td><td>D_{n-13}</td></tr><tr><td>DOWN</td><td>X</td><td>H</td><td>D_{n+3}</td><td>Off</td><td>D_{n-13}</td></tr></table> Note: OUT0 ~ 15 = on in case of D_n = H level and OUT0 ~ 15 = off in case of D_n = L level.	CLOCK	LATCH	ENABLE	SERIAL- IN	OUT0 ... OUT7 ... OUT15	SERIAL- OUT	UP	H	L	D _n	D _n ... D _{n-7} ... D _{n-15}	D _{n-15}	UP	L	L	D _{n+1}	No change	D _{n-14}	UP	H	L	D _{n+2}	D _{n+2} ... D _{n-5} ... D _{n-13}	D _{n-13}	DOWN	X	L	D _{n+3}	D _{n+2} ... D _{n-5} ... D _{n-13}	D _{n-13}	DOWN	X	H	D _{n+3}	Off	D _{n-13}
CLOCK	LATCH	ENABLE	SERIAL- IN	OUT0 ... OUT7 ... OUT15	SERIAL- OUT																																	
UP	H	L	D _n	D _n ... D _{n-7} ... D _{n-15}	D _{n-15}																																	
UP	L	L	D _{n+1}	No change	D _{n-14}																																	
UP	H	L	D _{n+2}	D _{n+2} ... D _{n-5} ... D _{n-13}	D _{n-13}																																	
DOWN	X	L	D _{n+3}	D _{n+2} ... D _{n-5} ... D _{n-13}	D _{n-13}																																	
DOWN	X	H	D _{n+3}	Off	D _{n-13}																																	
U5 & U6 & U7	Single 2-Input OR Gate; similar to Toshiba TC7SET32FU 	PIN-OUT DIAGRAM (TOP VIEW)  SSOP5 TRUTH TABLE <table><tr><th>A</th><th>B</th><th>Y</th></tr><tr><td>H</td><td>H</td><td>H</td></tr><tr><td>L</td><td>H</td><td>H</td></tr><tr><td>H</td><td>L</td><td>H</td></tr><tr><td>L</td><td>L</td><td>L</td></tr></table>	A	B	Y	H	H	H	L	H	H	H	L	H	L	L	L																					
A	B	Y																																				
H	H	H																																				
L	H	H																																				
H	L	H																																				
L	L	L																																				

13 INTERNAL INTERCONNECTION DIAGRAM



The above diagram applies to CH-721 remote-control applications, where a remote-control model of the CH-721 is mounted separately from the mobile radio. In this case, the CH-721 is connected to the radio via only a CAN link.

For local-control applications of the CH-721, where a local-control/front-mount model of the CH-721 is mounted directly to the front of the mobile radio, the Remote Interface Board is **not** used. In this case, connections from the mobile radio's PK Board are made via a flex-strip from a radio PK Board flex-strip connector to Display/DSP Board flex-strip connector J9.

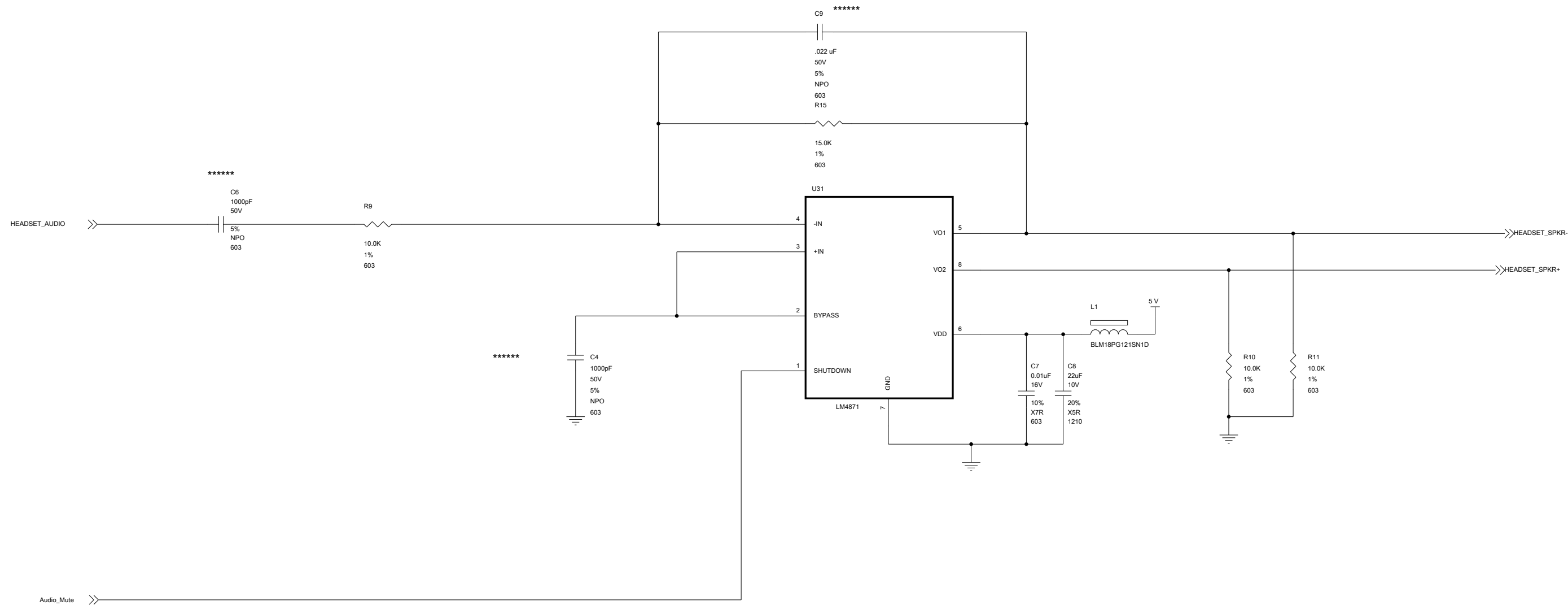
INTERNAL INTERCONNECTION DIAGRAM CH-721 CONTROL HEAD

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14 SCHEMATIC DIAGRAMS

14.1 DISPLAY/DSP BOARD CB103368V1

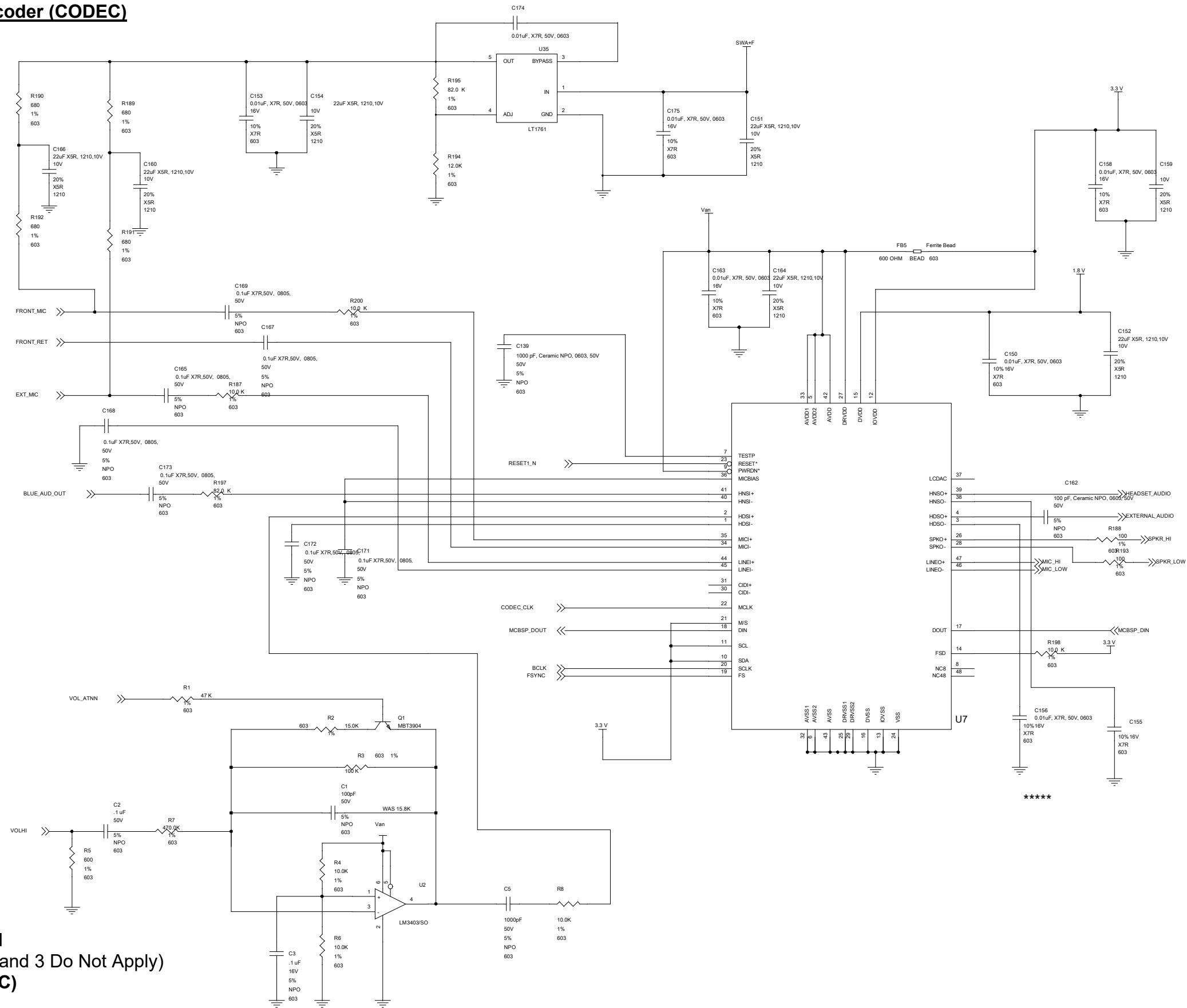
14.1.1 Headset Audio Amplifier



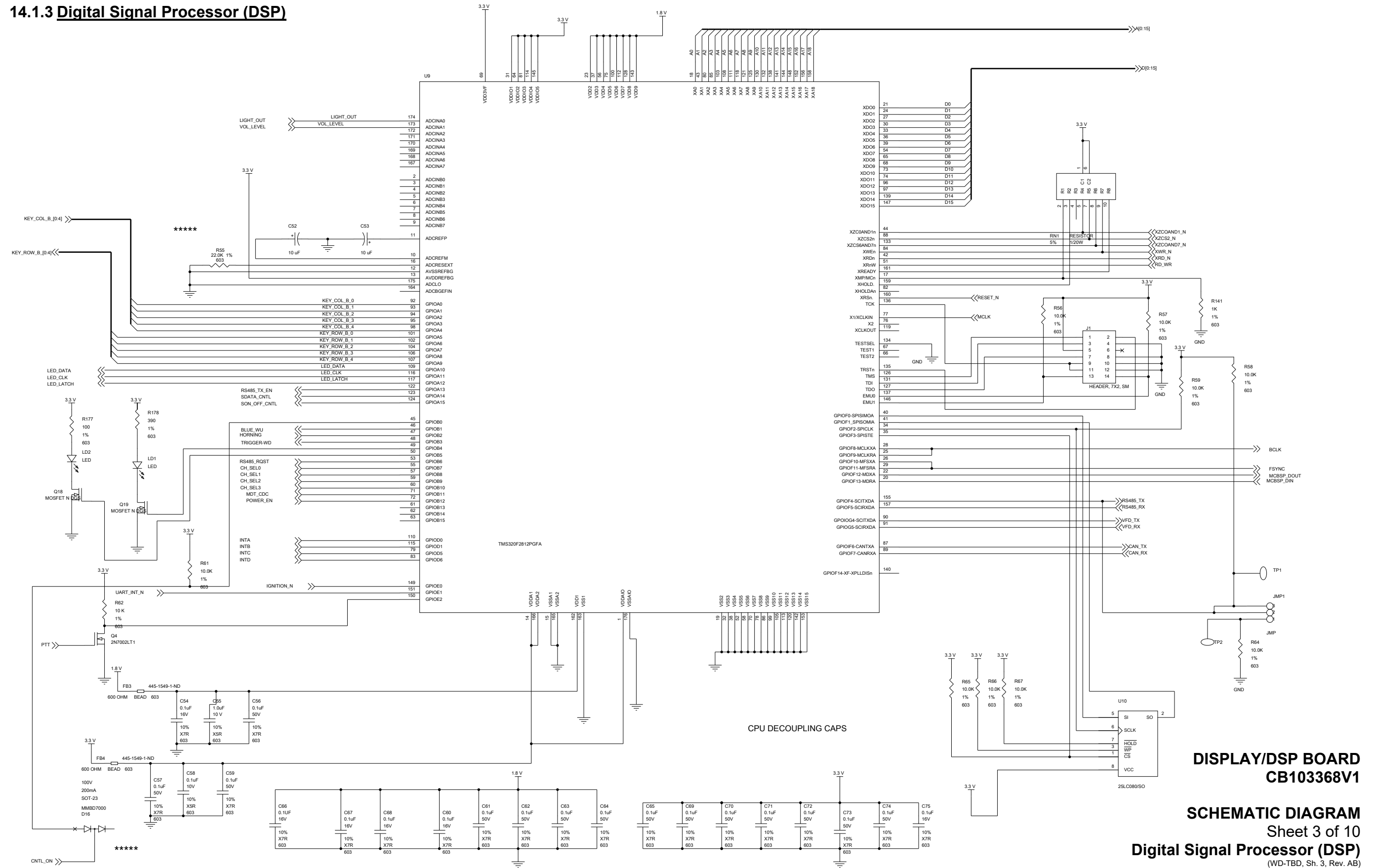
DISPLAY/DSP BOARD
CB103368V1

SCHEMATIC DIAGRAM
Sheet 1 of 10
Headset Audio Amplifier
(WD-TBD, Sh. 1, Rev. AB)

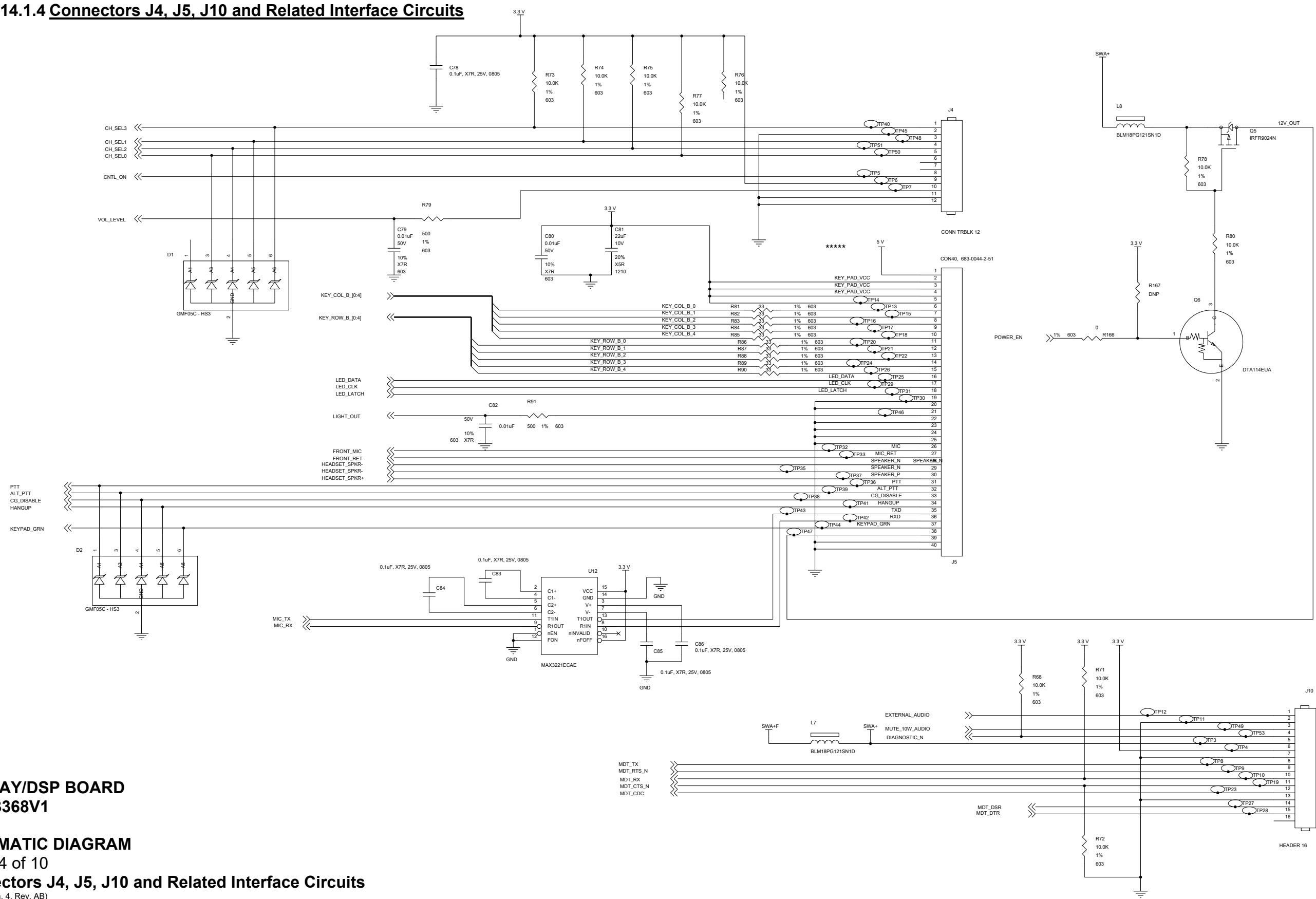
14.1.2 Coder-Decoder (CODEC)



14.1.3 Digital Signal Processor (DSP)



14.1.4 Connectors J4, J5, J10 and Related Interface Circuits



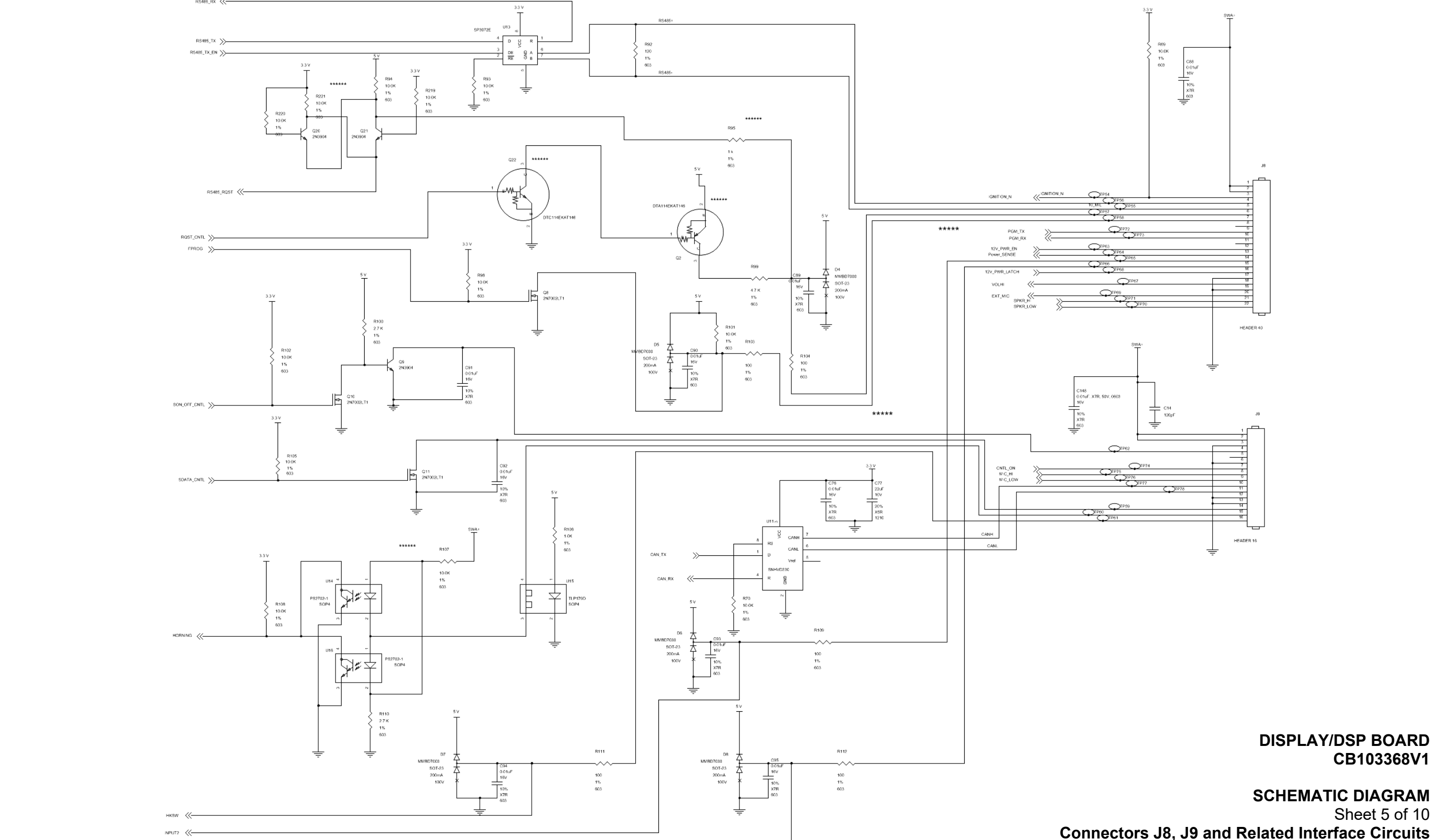
DISPLAY/DSP BOARD
CB103368V1

SCHEMATIC DIAGRAM

Sheet 4 of 10

Connectors J4, J5, J10 and Related Interface Circuits

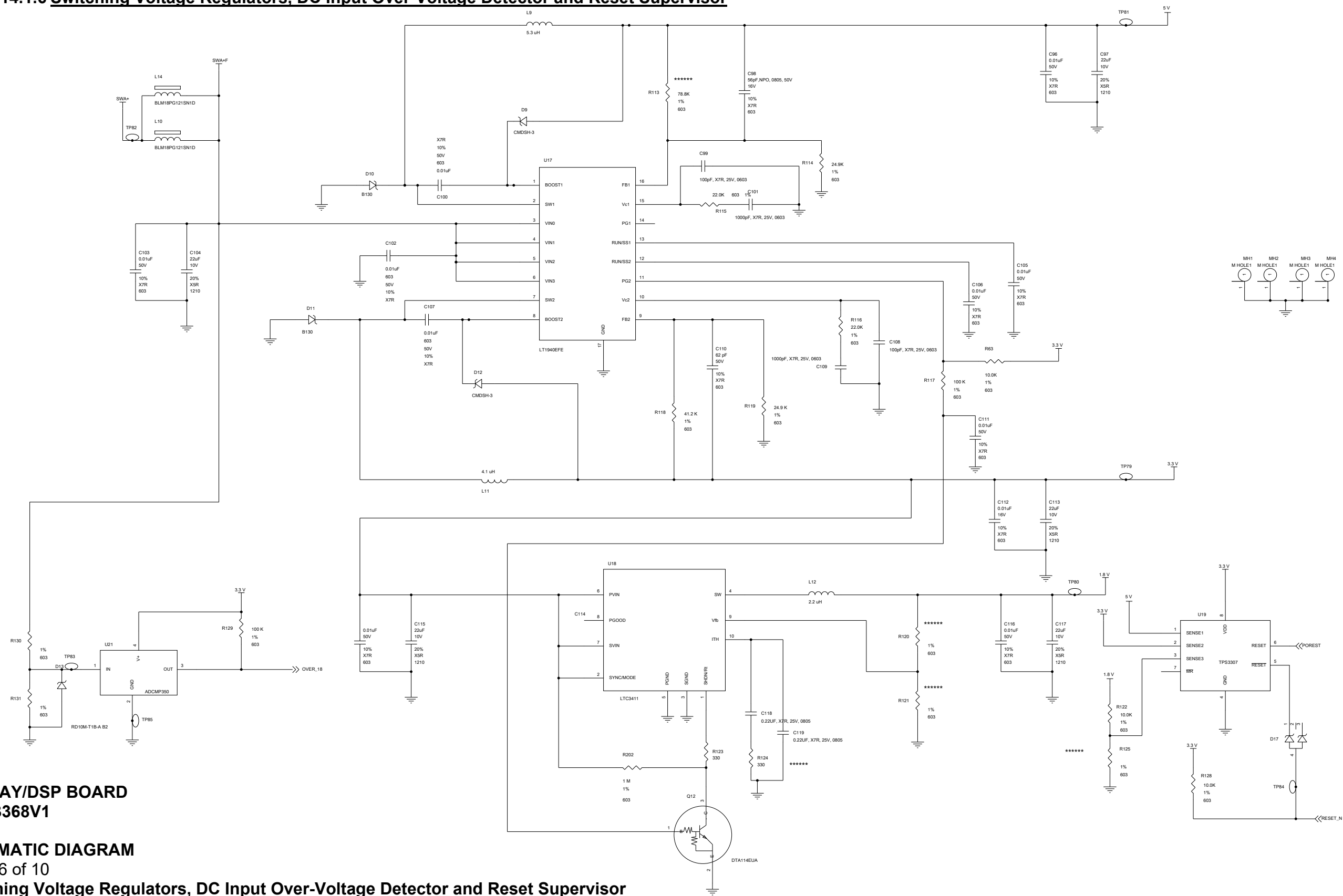
(WD-TBD, Sh. 4, Rev. AB)



SCHEMATIC DIAGRAM
Sheet 5 of 10

CONNECTORS J8, J9 AND RELATED INTERFACE CIRCUITS (WD-TBD, Sh. 5, Rev. AB)

14.1.6 Switching Voltage Regulators, DC Input Over-Voltage Detector and Reset Supervisor



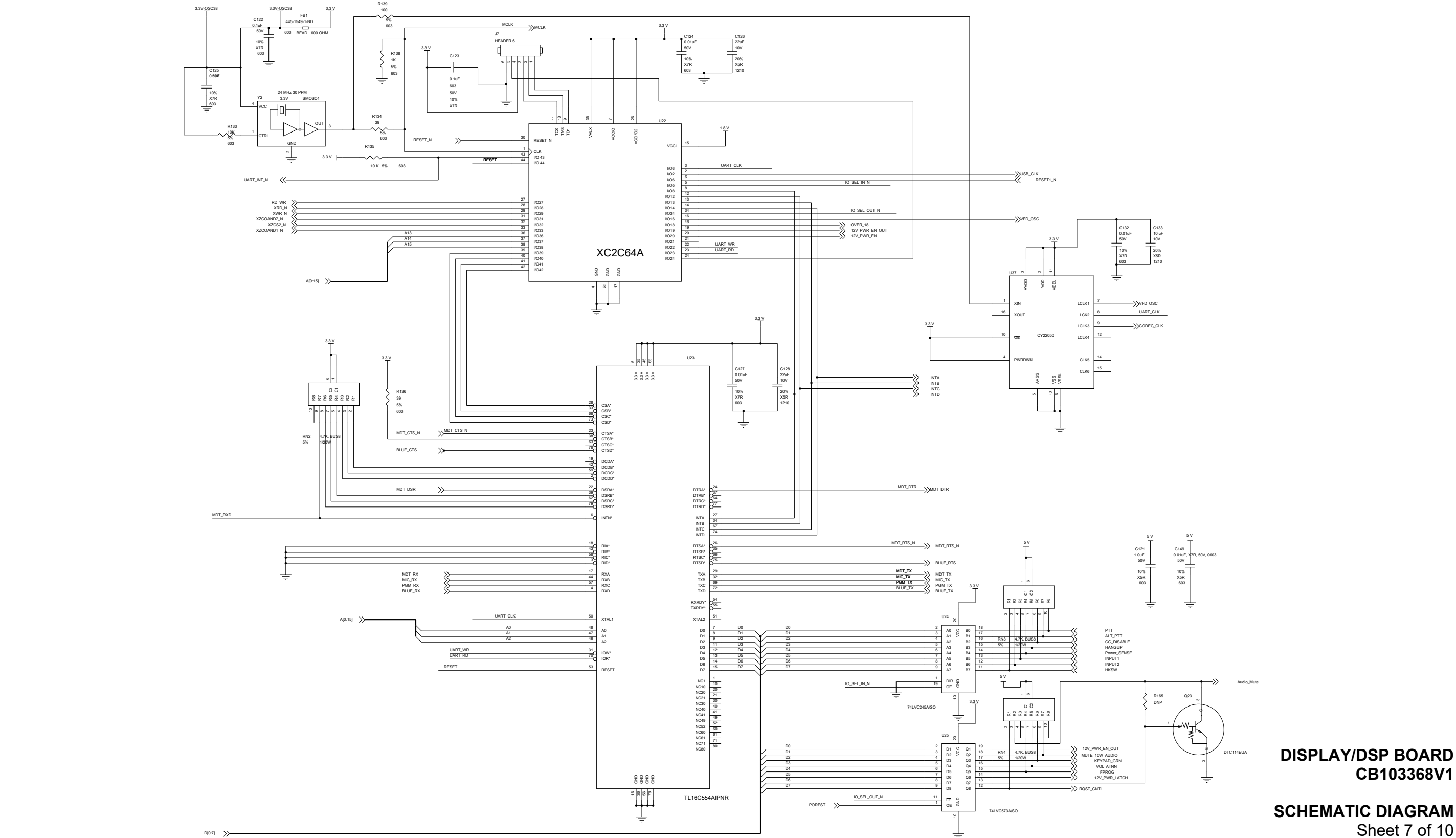
DISPLAY/DSP BOARD
CB103368V1

SCHEMATIC DIAGRAM

Sheet 6 of 10

Switching Voltage Regulators, DC Input Over-Voltage Detector and Reset Supervisor

(WD-TBD, Sh. 6, Rev. AB)



SCHEMATIC DIAGRAM

Generator, CPLD and ACE

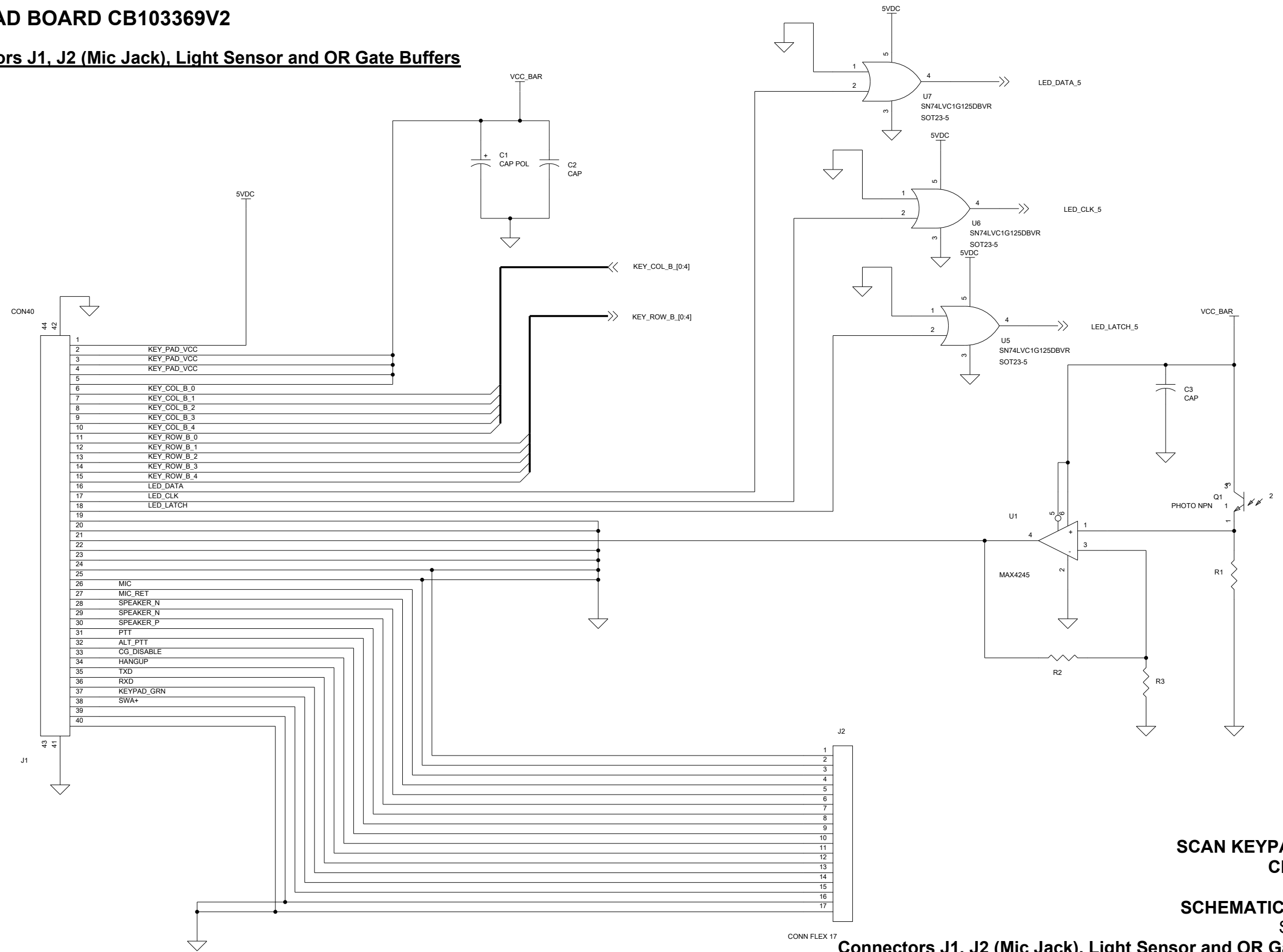
(WD-100, Sh. 7, Rev. AB)

SCHEMATIC DIAGRAM

Display, Display Controller and 43 V Display Power Supply

14.2 SCAN KEYPAD BOARD CB103369V2

14.2.1 Connectors J1, J2 (Mic Jack), Light Sensor and OR Gate Buffers



SCAN KEYPAD BOARD
CB103369V2

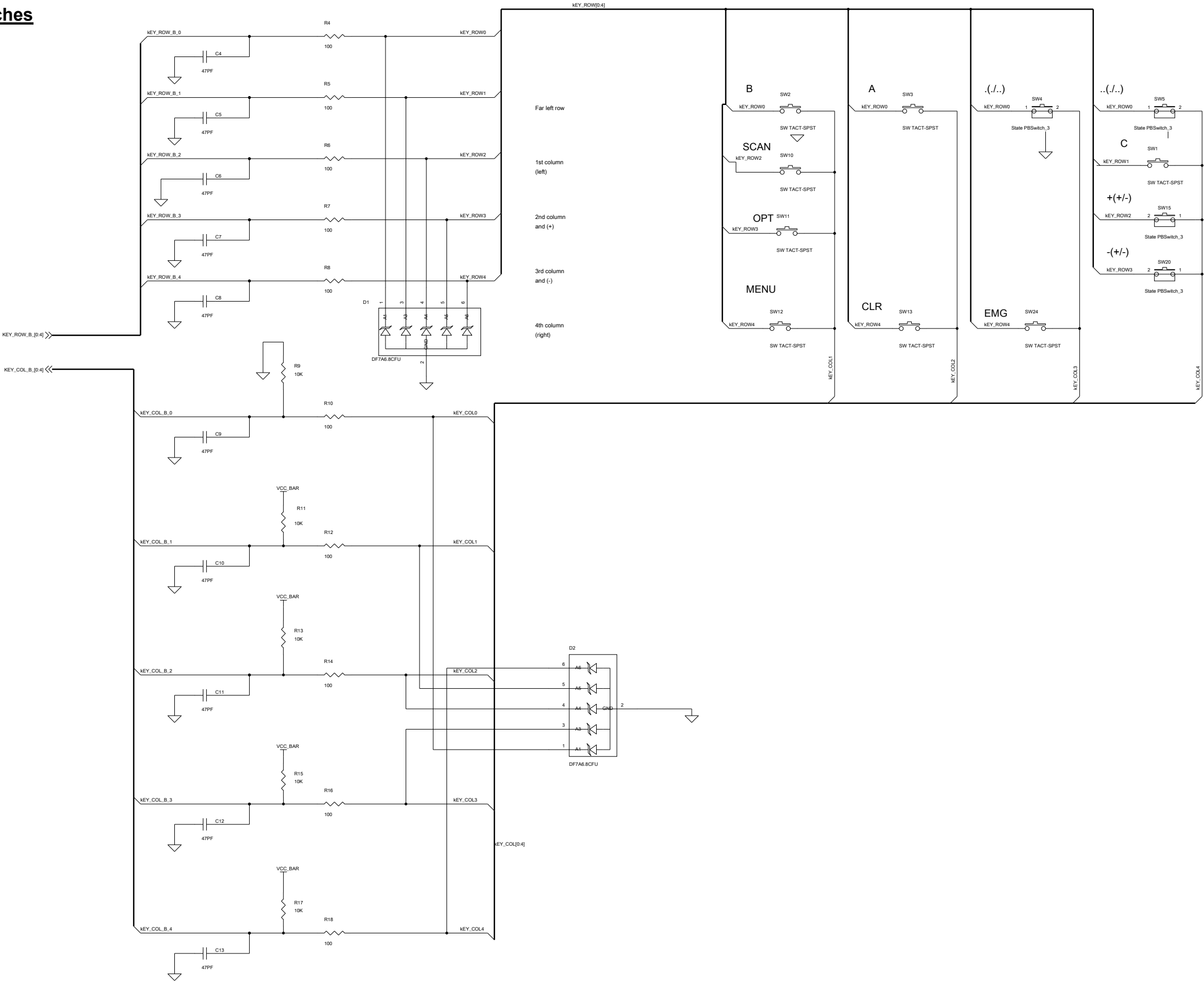
SCHEMATIC DIAGRAM

Sheet 1 of 3

EX 17 Connectors J1, J2 (Mic Jack), Light Sensor and OR Gate Buffers

(WD-TBD, Sh. 1, Rev. 200605231)

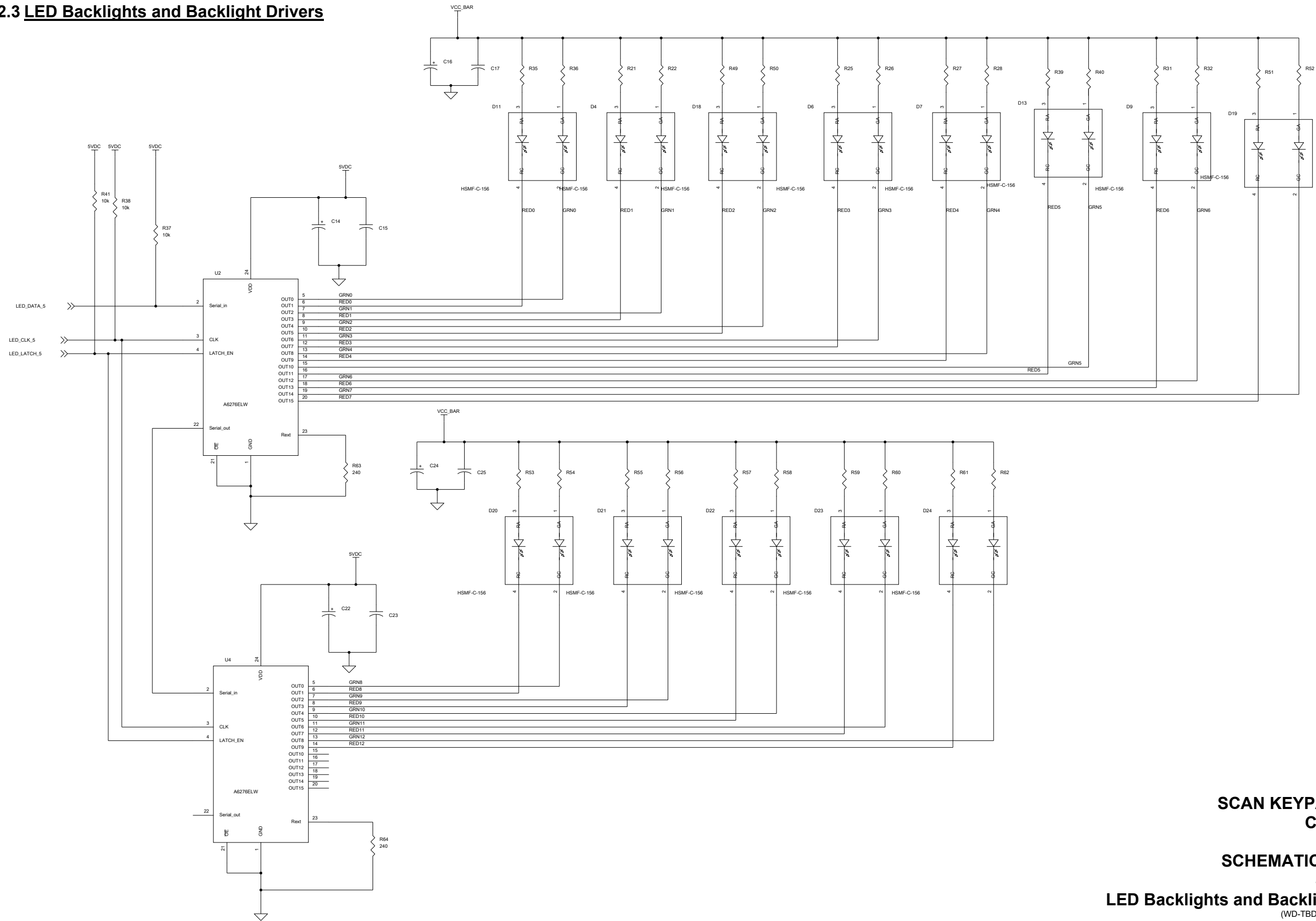
14.2.2 Keypad Switches



SCAN KEYPAD BOARD
CB103369V2

SCHEMATIC DIAGRAM
Sheet 2 of 3
Keypad Switches
(WD-TBD, Sh. 2, Rev. 20060531)

14.2.3 LED Backlights and Backlight Drivers

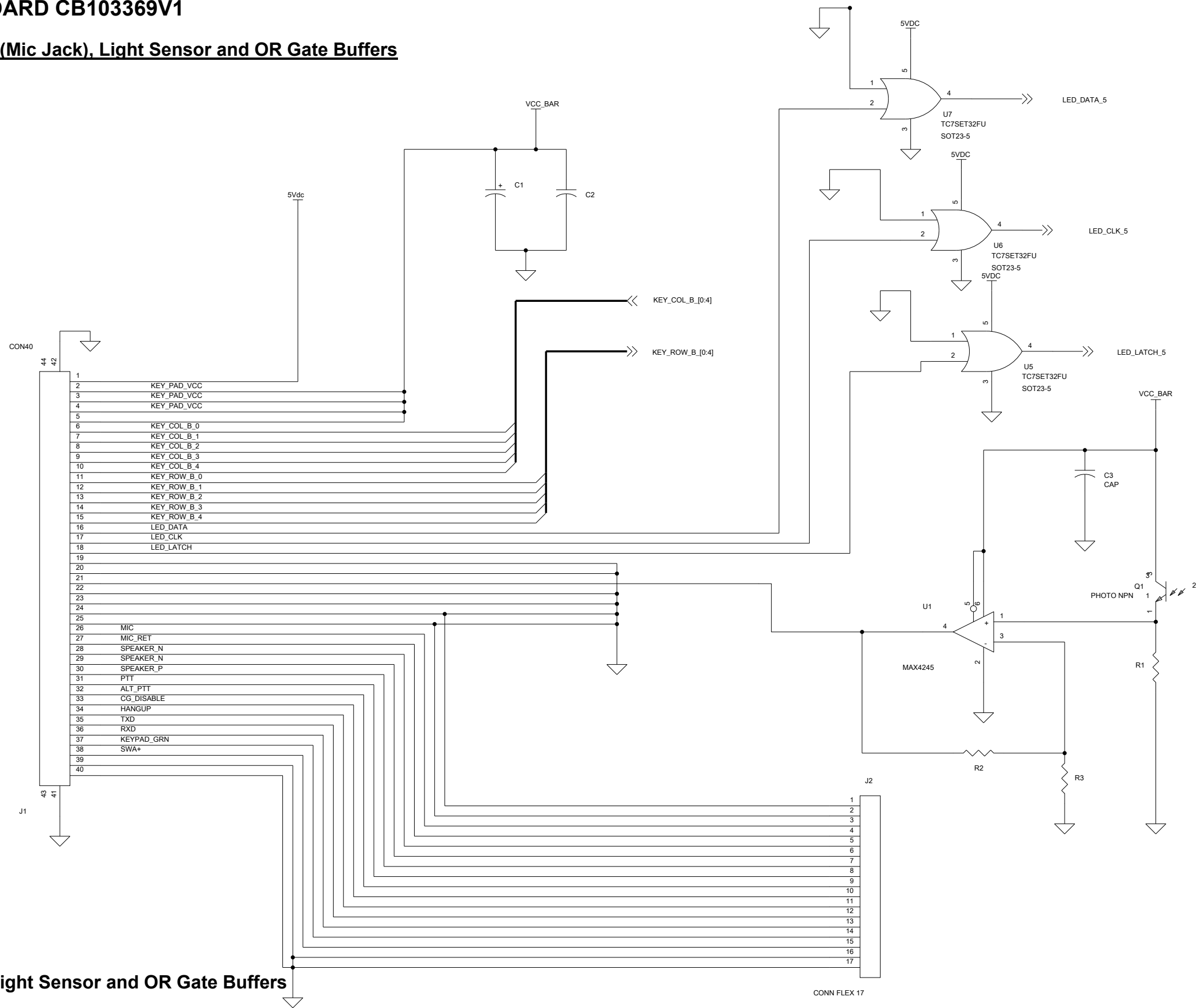


SCAN KEYPAD BOARD
CB103369V2

SCHEMATIC DIAGRAM
Sheet 3 of 3
LED Backlights and Backlight Drivers
(WD-TBD, Sh. 3, Rev. 20060531)

14.3 SYSTEM KEYPAD BOARD CB103369V1

14.3.1 Connectors J1, J2 (Mic Jack), Light Sensor and OR Gate Buffers



SYSTEM KEYPAD BOARD
CB103369V1

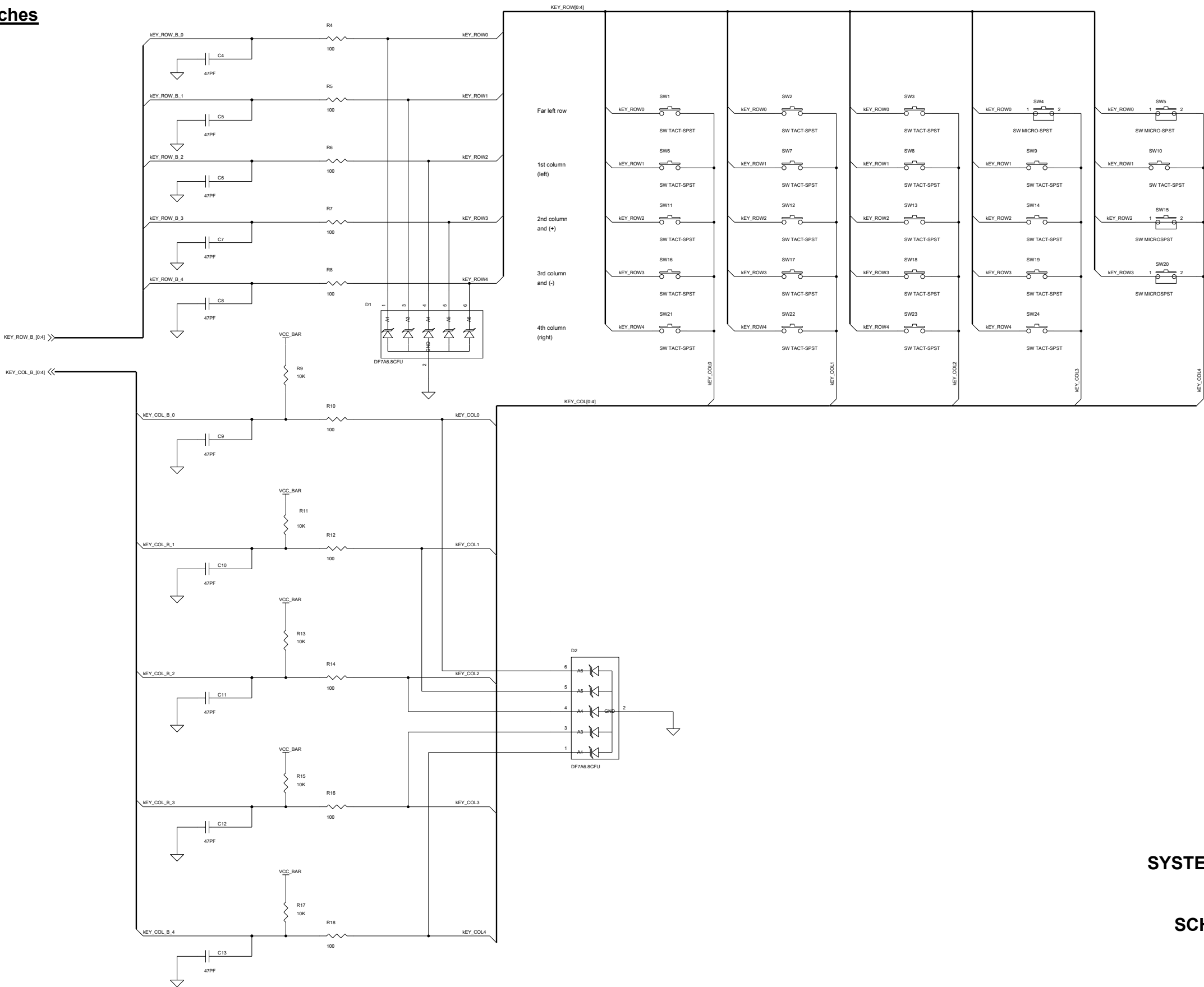
SCHEMATIC DIAGRAM

Sheet 1 of 3

Connectors J1, J2 (Mic Jack), Light Sensor and OR Gate Buffers

(WD-TBD, Sh. 1, Rev. 20060601)

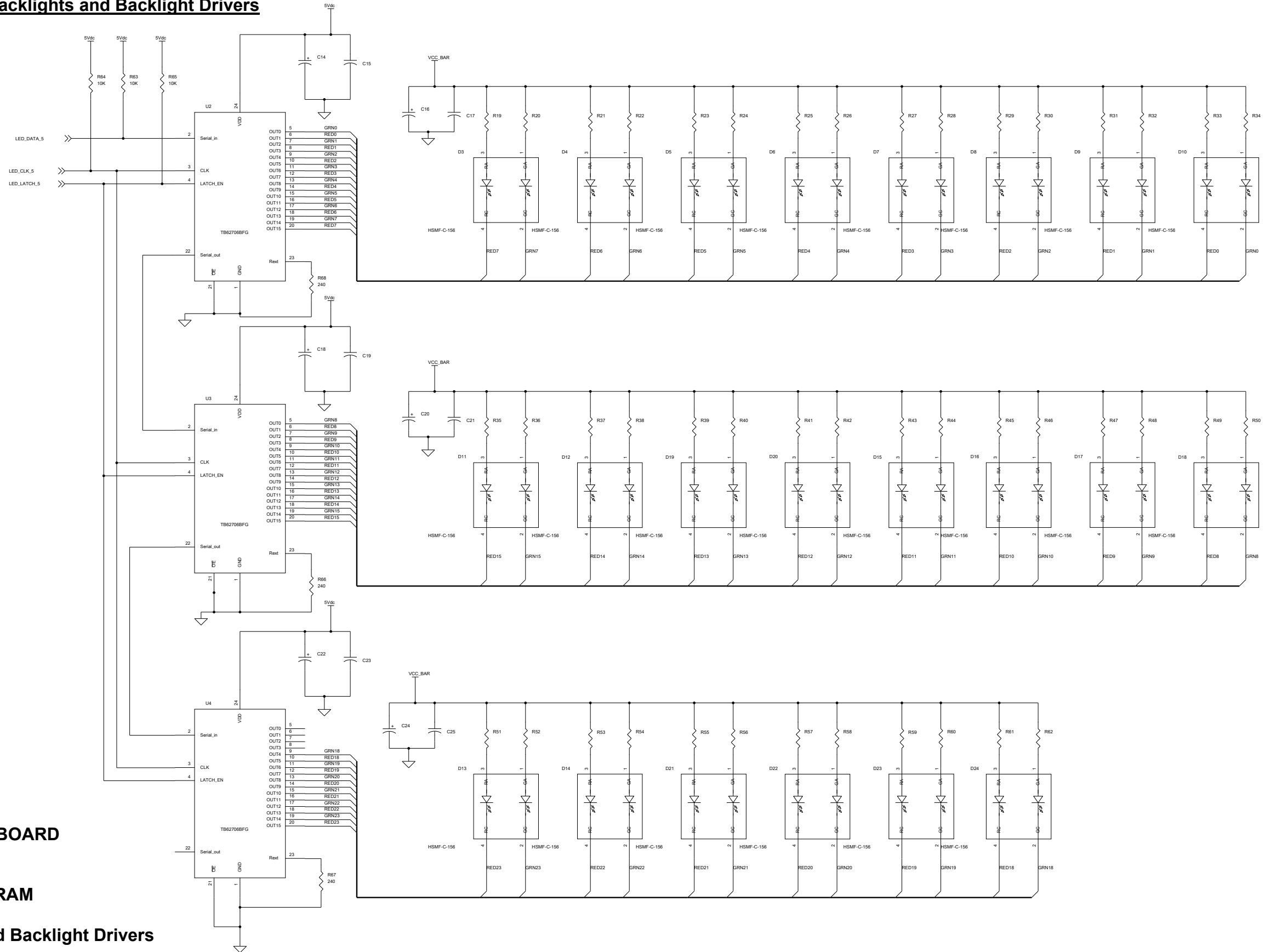
14.3.2 Keypad Switches



SYSTEM KEYPAD BOARD
CB103369V1

SCHEMATIC DIAGRAM
Sheet 2 of 3
Keypad Switches
(WD-TBD, Sh. 2, Rev. 20060601)

14.3.3 LED Backlights and Backlight Drivers



SYSTEM KEYPAD BOARD

CB103369V1

SCHEMATIC DIAGRAM

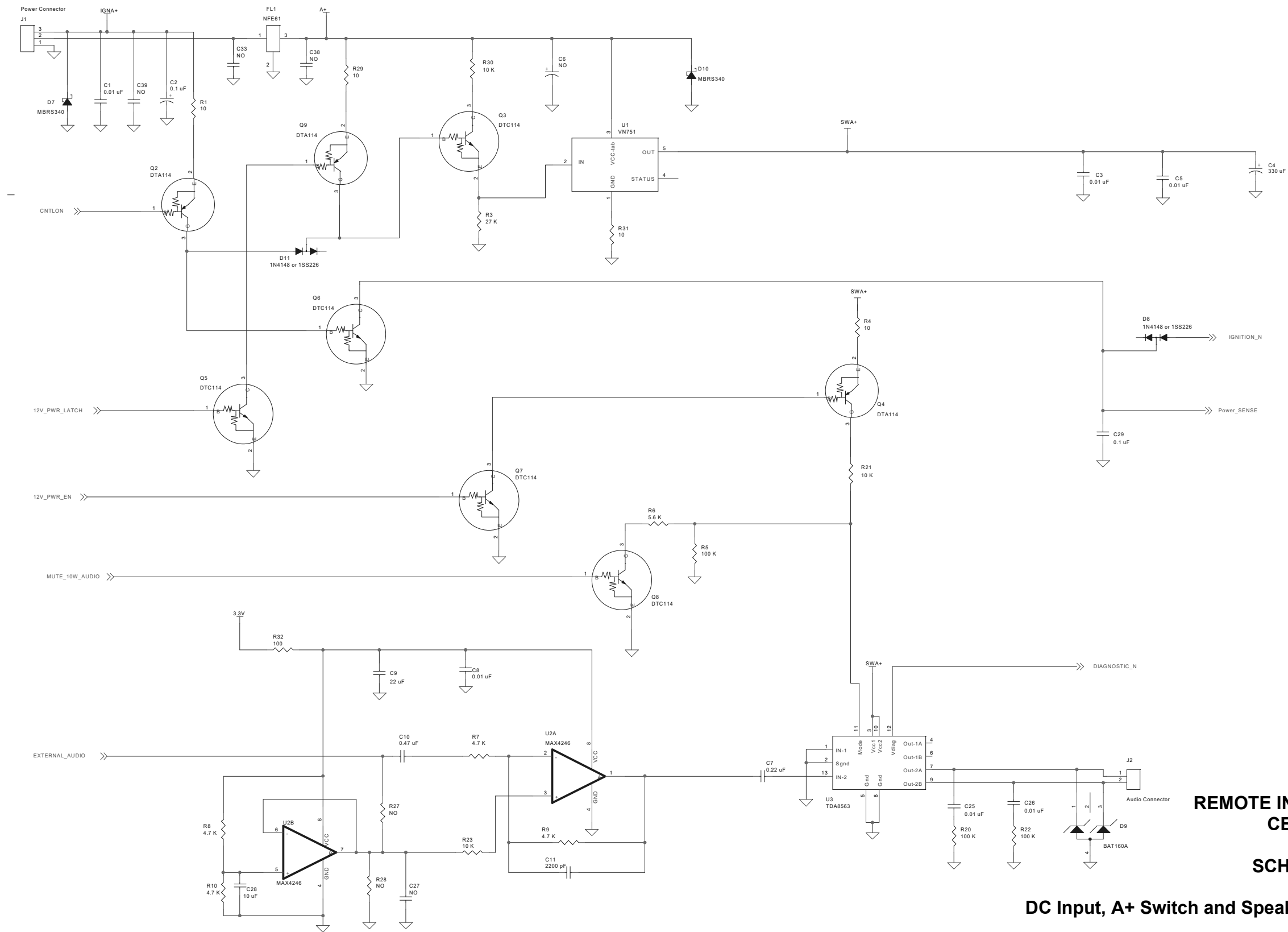
Sheet 3 of 3

LED Backlights and Backlight Drivers

(WD-TBD, Sh. 3, Rev. 20060601)

14.4 REMOTE INTERFACE BOARD CB23224-0001 Rev. C

14.4.1 DC Input, A+ Switch and Speaker Audio Amplifier



REMOTE INTERFACE BOARD
CB23224-0001 Rev. C

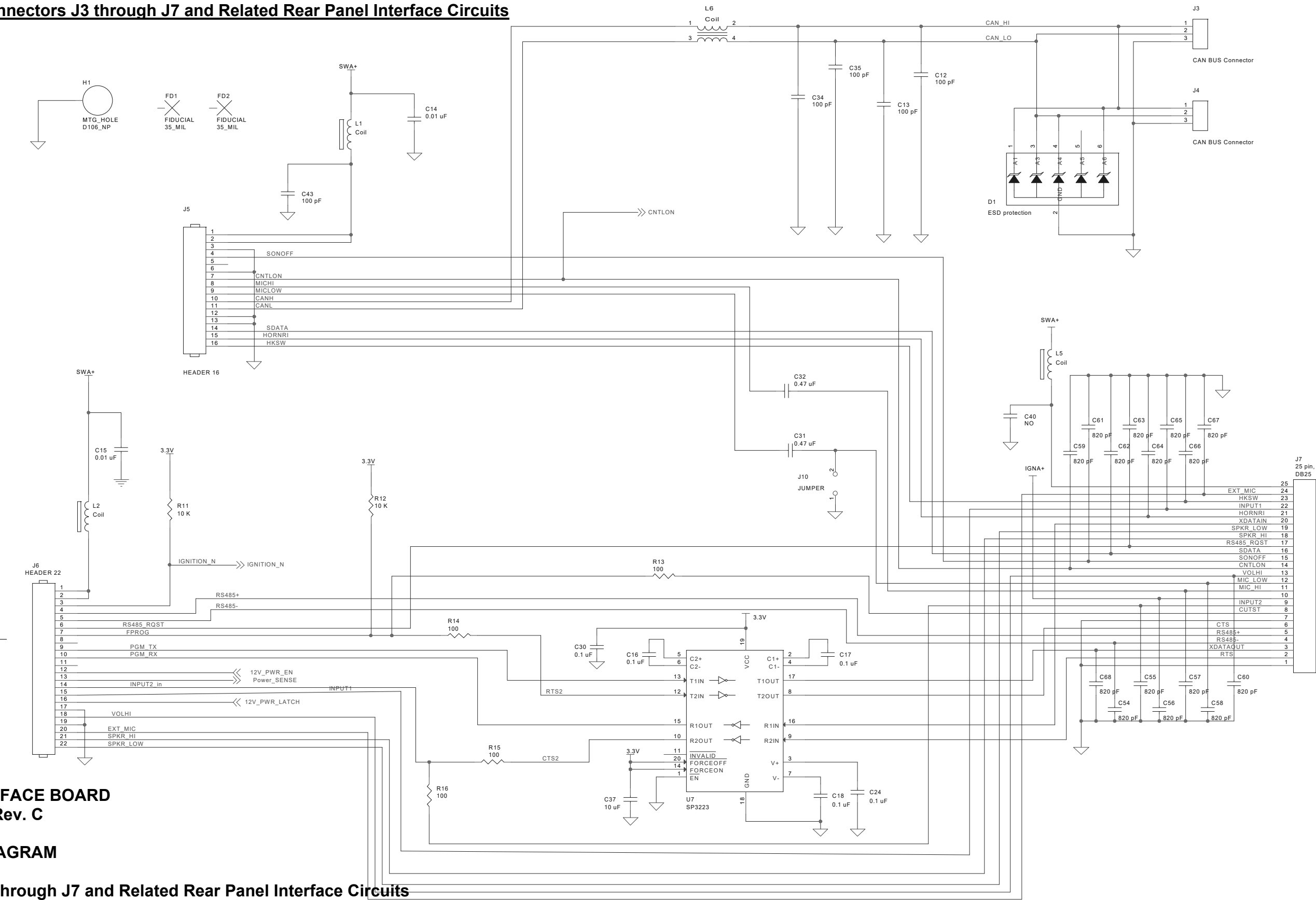
SCHEMATIC DIAGRAM

Sheet 1 of 3

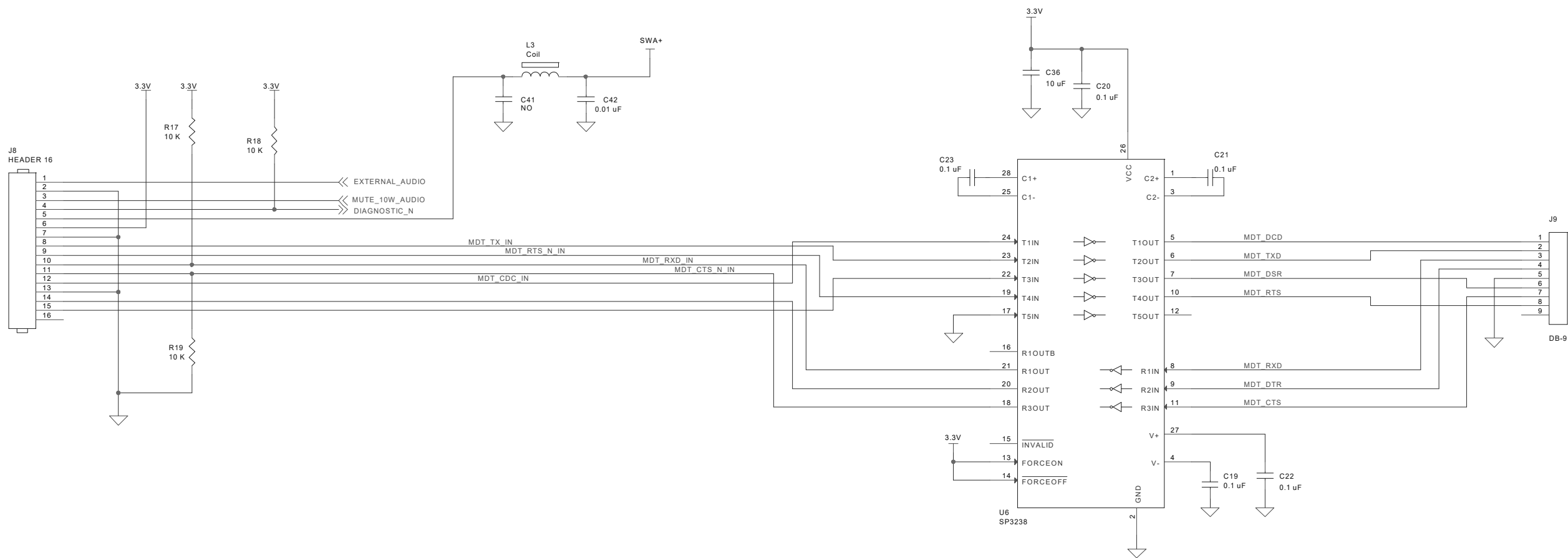
DC Input, A+ Switch and Speaker Audio Amplifier

(WD-CB23224-0001, Sh. 1, Rev. C)

14.4.2 Connectors J3 through J7 and Related Rear Panel Interface Circuits



14.4.3 DB-9 Serial Port Transceiver

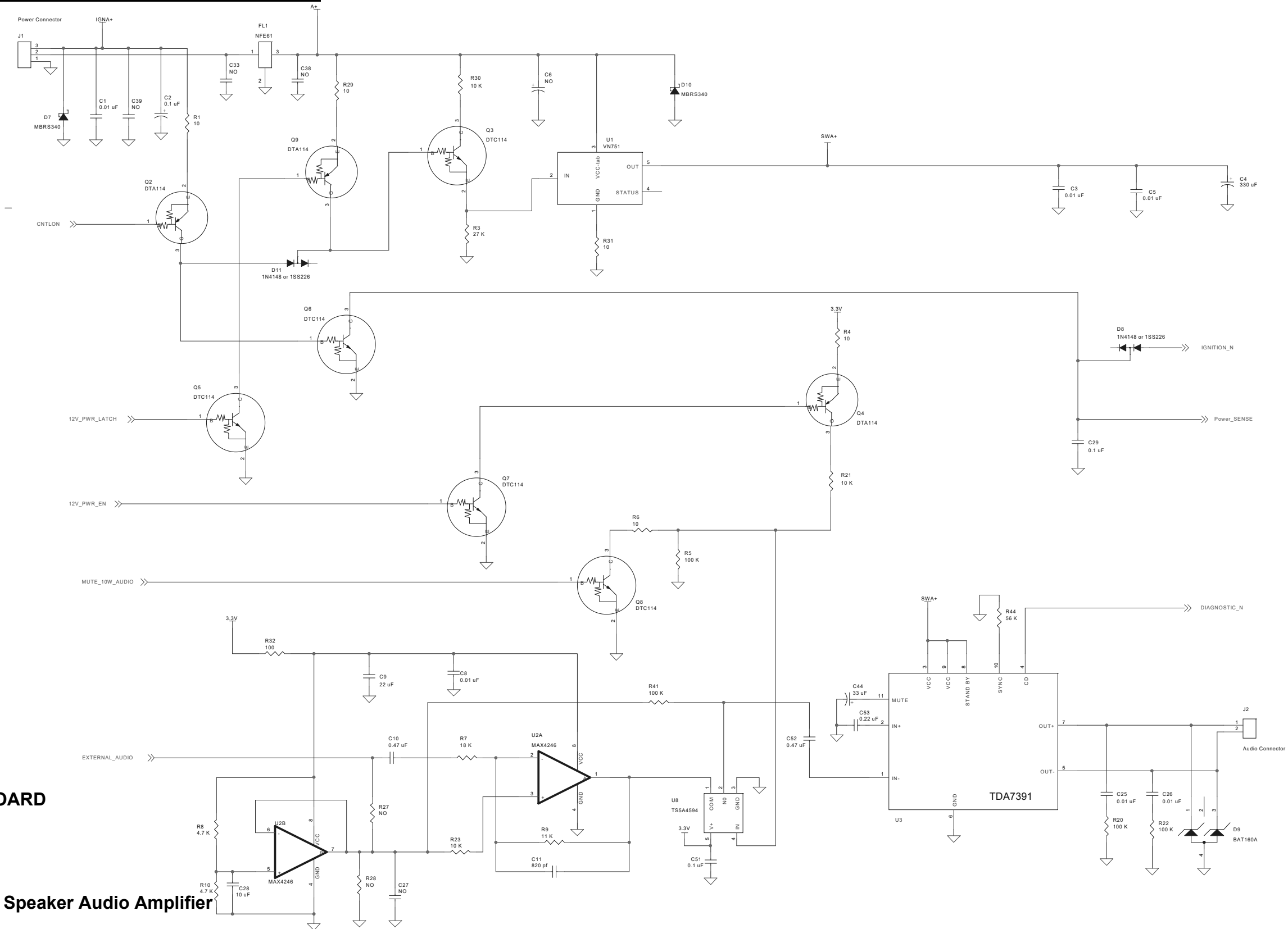


REMOTE INTERFACE BOARD
CB23224-0001 Rev. C

SCHEMATIC DIAGRAM
Sheet 3 of 3
DB-9 Serial Port Transceiver
(WD-CB23224-0001, Sh. 3, Rev. C)

14.5 REMOTE INTERFACE BOARD CB23224-0001 Rev. D

14.5.1 DC Input, A+ Switch and Speaker Audio Amplifier



REMOTE INTERFACE BOARD
CB23224-0001 Rev. D

SCHEMATIC DIAGRAM

Sheet 1 of 3

DC Input, A+ Switch and Speaker Audio Amplifier

(WD-CB23224-0001, Sh. 3, Rev. D)

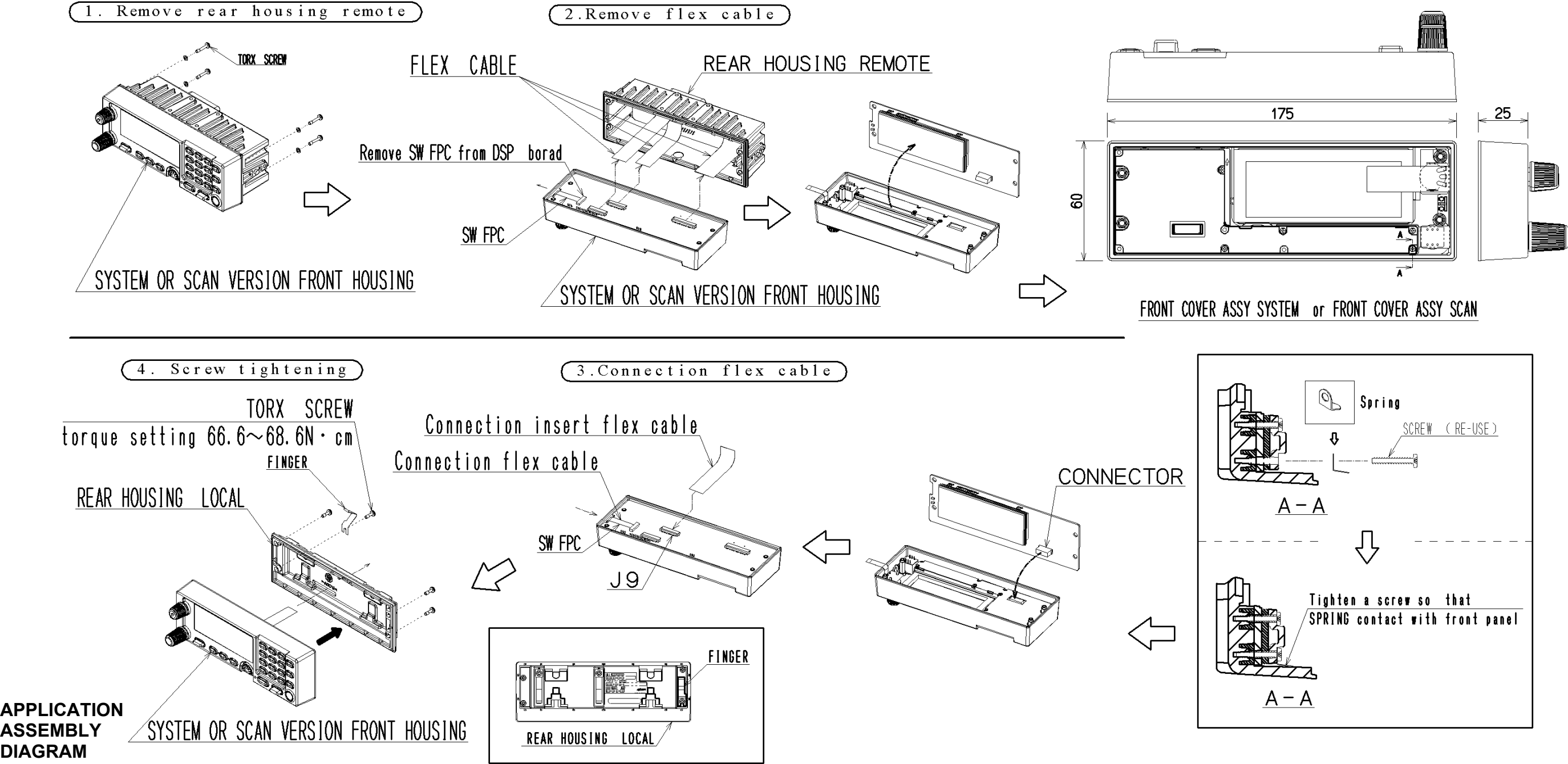
(WD-CB23224-0001, Sh. 3, Rev. D)

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15 APPLICATION ASSEMBLY DIAGRAM

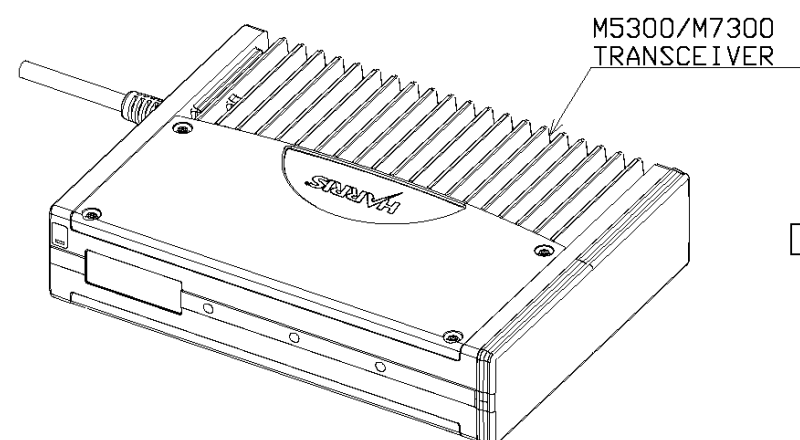
15.1 CONVERTING A REMOTE-MOUNT M5300/M7300 RADIO TO A FRONT-MOUNT RADIO

15.1.1 Converting the Remote-Mount CH-721 to a Front-Mount CH-721

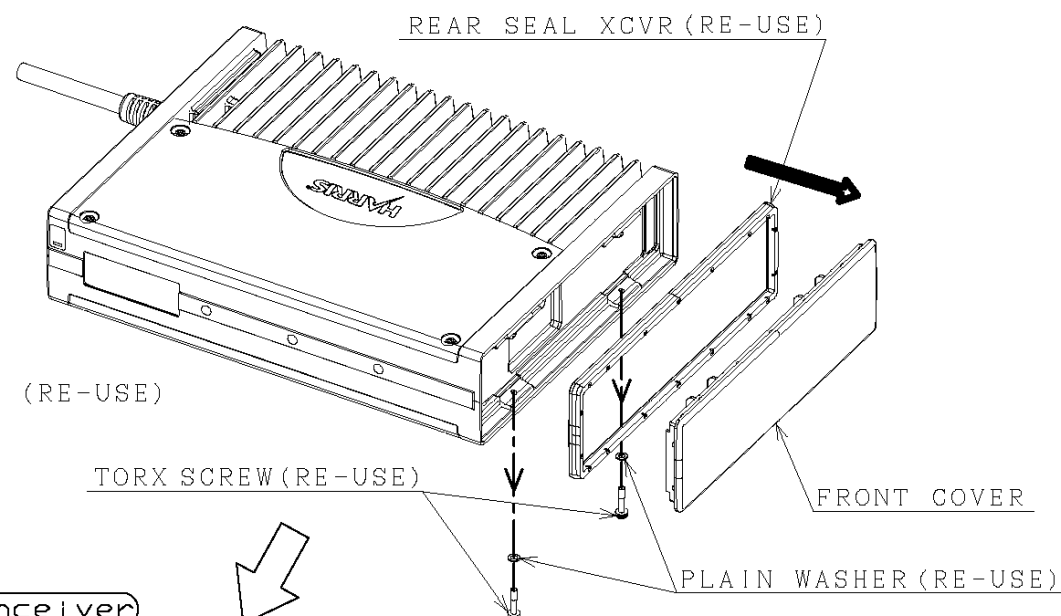


15.1.2 Mounting a Front-Mount CH-721 to the Radio

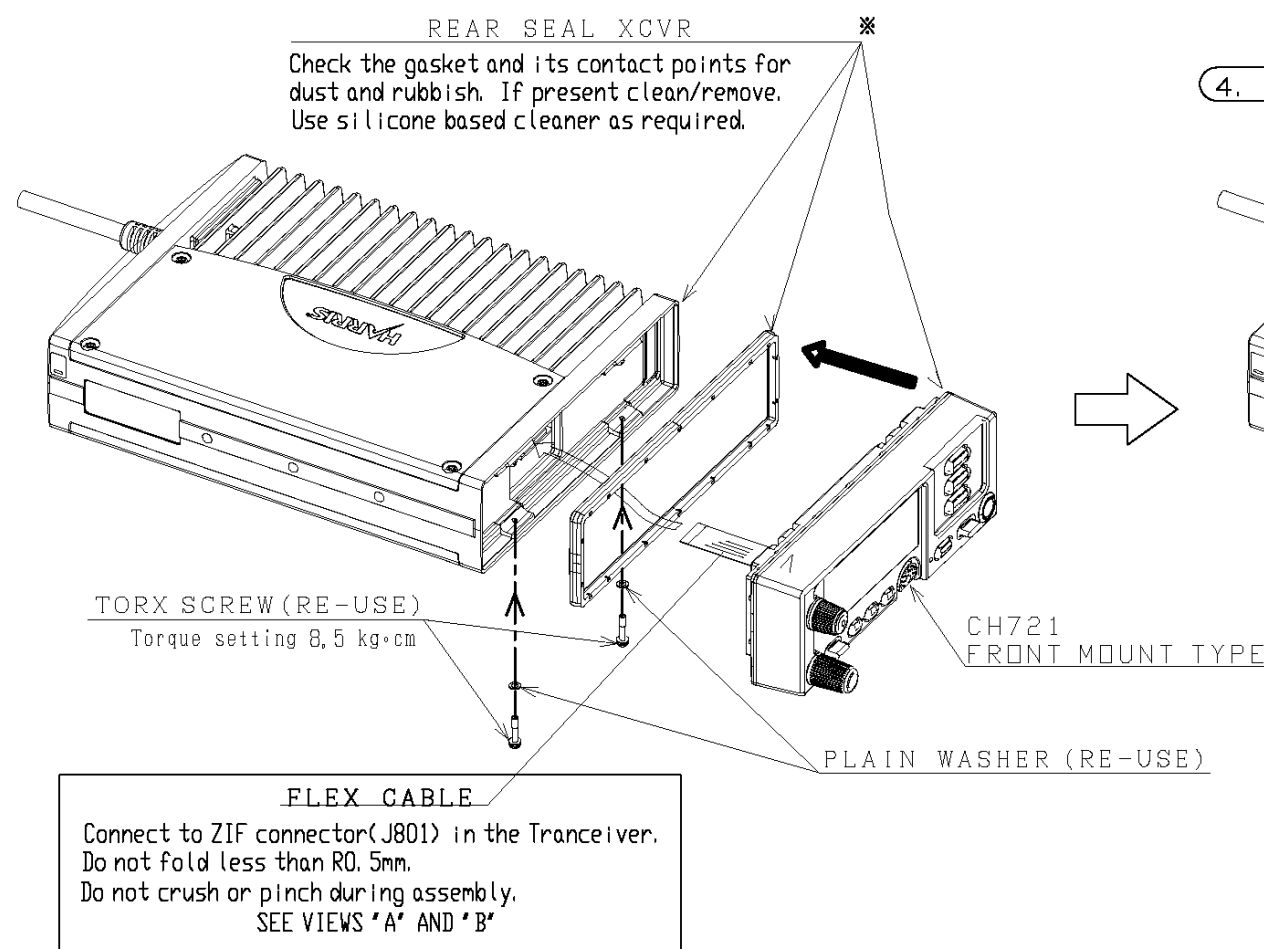
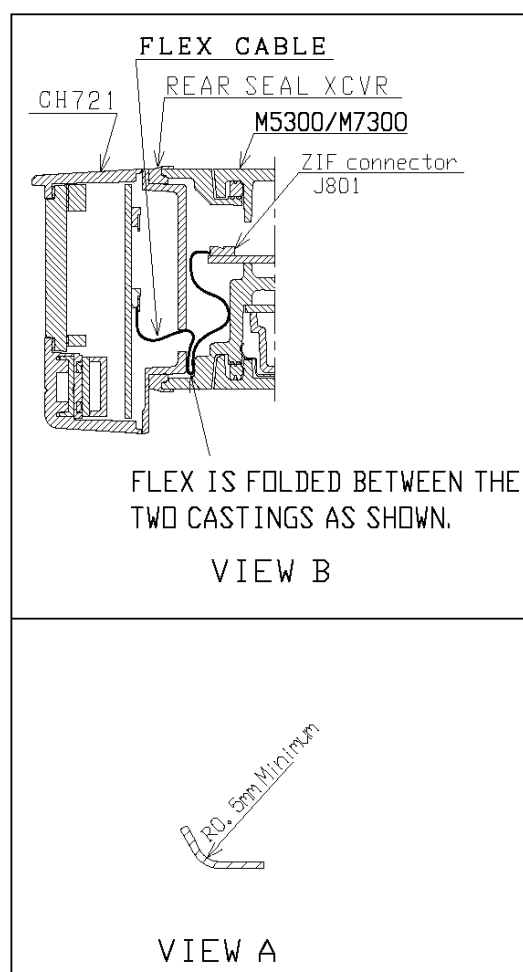
1. REMOTE TYPE Transceiver



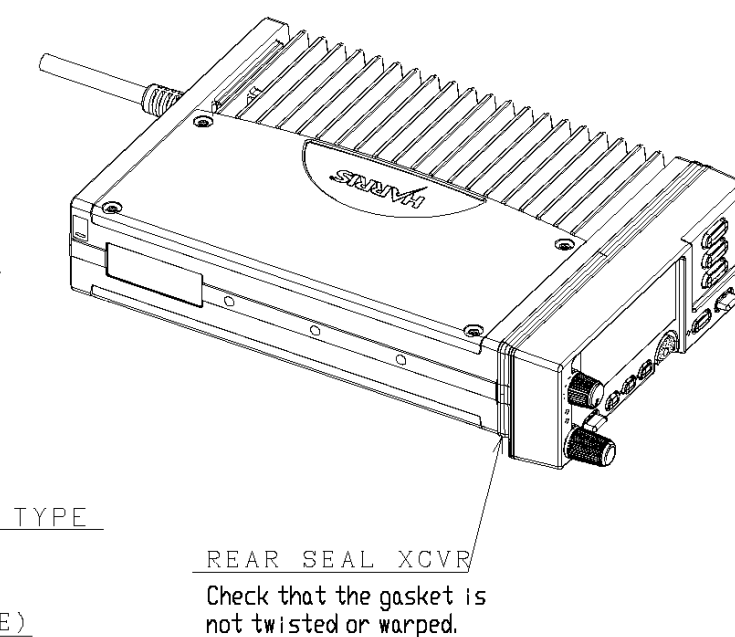
2. Remove Front cover



3. Build CH721 and Transceiver



4. Check REAR SEAL XCVR



**APPLICATION
ASSEMBLY
DIAGRAM**

**CONVERTING A REMOTE-MOUNT
M5300/M7300 RADIO TO A FRONT-MOUNT RADIO**
Mounting a Front-Mount CH-721 to the Radio

(AA01-MAHK Rev. -)

**Schematic Diagrams and
Application Assembly Diagrams Inside**

About L3Harris Technologies

L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers’ mission-critical needs. The company provides advanced defense and commercial technologies across air, land, sea, space and cyber domains.